# MEAT HYGIENE

By

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# PREFACE TO THE SECOND EDITION

SINCE publication of the first edition, the poultry inspection phase of the subject of meat hygiene has received increasing attention. For example, a law has been enacted in the Federal jurisdiction that provides for setting up a Federal poultry inspection program having authorities and responsibilities similar to the Federal meat inspection program. This edition includes, therefore, such additional detail and references that cover specifically those points of difference that characterize each program and give general treatment to those aspects that apply equally to both programs.

It appears to be appropriate that this preface risk the criticism of being repetitive by including some general comment on the subject of meat hygiene. It is intended that this comment will serve to introduce the student to the subject.

Meat hygiene is best understood when one identifies its role in the realm of public interest. A useful meat hygiene program must effectively satisfy the interest of the public individually in the character of his meat supply and the interest of the public generally in a sound, vigorous livestock, poultry, and meat economy that can make major contributions to the Nation's economy. Actually, that which is necessary to be done to satisfy the individual's interest in his meat supply also serves to guarantee the broader public interest in a sound, national economy because it is the individual's purchasing dollar that supports that economy.

It does not detract from the significance or importance of the elements that are identified as making up the meat hygiene interests of the individual because these interests derive from his being a member of civilized society or even a complicated society. His interest in decency must receive as much thoughtful attention as is given to his interest in safety. Similarly, the individual is entitled to be protected against the fraud hazards of the market place which are inevitably a product of a complicated society.

The routines that are applied in the packing plant, whether it is a meat packing plant or a poultry processing plant and that have for their purpose the application of standards of common decency in the preparing and handling of meat food are similar to those that make it a safe food. Common decency and safety, nevertheless, have two separate and distinct objectives. In no case are the two to be confused one with the other, or one sacrificed for the other. Food must be prepared in a clean environment. It must be clean and free from contamination because that is the way the consumer wants it. It is no answer that unclean food can be made harmless by sterilization. On the other hand even an esthetically acceptable method of handling a food cannot be permitted to be used if the food as a result of that method of handling is unsafe when eaten.

As the clean, wholesome meat is brought to the market place, we find another area of consumer interest. The consumer is entitled to be protected against economic frauds. The food must not be adulterated nor misbranded.

Again, it is not enough to say that the food will not harm the purchaser if, in fact, its composition is not that which the consumer is entitled to expect it to be, or if the label on the food represents it as being a food of higher value than it is in fact.

The Nation's livestock and poultry industries thrive only to the extent that the consumer has confidence in and will buy the products of these industries. The important contribution that is made by the meat hygiene program to this consumer-industry relationship is attested to by laws setting up meat hygiene controls in all Nations of the world identified with the so-called Western civilization. These programs are in effect inspection programs and they are commonly known as such, namely. Meat Inspection program or Poultry Inspection program.

These inspection programs are action programs that place official inspectors in the production lines of packing plants. To function effectively, these inspectors must know the extent and limitations of their authority and responsibility. These, of course, are determined by the language of the legislation under which the program is organized. Then, for the program to function effectively, the inspector must know and understand the industry that is subject to the inspection program, the industry's production procedures, its products, and its merchandising practices. All of this is necessary because the inspection program controls must be those that are reasonably necessary to attain the objectives of the law, and at the same time studiously observe the rights of all parties under the law.

In addition to the poultry coverage, this edition includes fuller handling of the two introductory chapters on "History" and "Elements of Meat Hygiene", and three new chapters. The background material added to the first two chapters should set the stage somewhat better for the students' introduction to what might be characterized as a social-legal subject.

The three new chapters cover the subjects of "Food Poisoning", "Chemical Additives", and "Ionizing Radiation." The chapter on food poisoning is a more detailed handling of the subject than in the first edition. The subjects of "Chemical Additives" and "Ionizing Radiation" were not included in the first edition.

I want to express my gratitude to Dr. Graydon S. McKee of the Poultry Division of the Agricultural Marketing Service and to Dr. Paul J. Brandly of the Meat Inspection Division of the Agricultural Research Service in helping to resolve questions concerned more particularly with poultry inspection and the biological sciences.

WASHINGTON, D.C. A. R. MILLER

# PREFACE TO THE FIRST EDITION

MEAT hygiene as dealt with in this text covers the broad field it has attained in the United States. The text is addressed primarily to veterinary students and veterinarians because, as a group, they are prepared by their education and training to perform two basic services in the field of meat hygiene, namely, ante-mortem examination of food animals and post-mortem examination of their carcasses. Yet the subject of meat hygiene is broader than ante-mortem and post-mortem services combined.

Meat hygiene is as broad as the consumer's interest in the meat he eats. He expects his meat to be derived from animals that are healthy at the time of slaughter. He expects these animals to be slaughtered under conditions that assure the elimination of diseased carcasses and meat. He expects that the meat will be kept clean and handled under clean conditions during each stage of its preparation and merchandising up until the time it reaches his table.

He expects, furthermore, that there will be no adulteration of the meat during its handling and preparation, and as a companion interest, he expects truthful labeling. Grading and grade labeling have come into the field of consumer interest in recent years. This subject, therefore, is also included in this text.

It is important that the student and practitioner of meat hygiene realize that meat hygiene does not constitute some luxury which might be handled lightly or overlooked entirely in the many activities of the slaughterhouse or market place. On the contrary, the consumer, as a member of modern society, is entitled as a matter of right to have the meat he eats handled *and prepared with full regard for all recognized principles of meat hygiene.*

Those who expect to engage in the field of meat hygiene control have the responsibility of learning thoroughly all the principles involved so as to be able to apply them effectively. Such application depends on individual initiative functioning in an adequate control program.

This text covers all levels of responsibility. The principles are the same for a small butcher shop as for the largest packing house and except as volume may be a complicating influence, the detailed handling of operations is similar. The author hopes that, in addition to persons of veterinary training, others responsible for sanitation and supervision of meat processing will find this text useful by observing how their duties supplement the functions of veterinarians in the complete program of control.

Since the intelligent application of the principles of meat hygiene leads to consumer acceptance of the products of a vast livestock industry, it serves a two-fold purpose. It protects the public meat supply and safeguards the Nation's livestock economy.

A. R. MILLER

WASHINGTON, D.C.

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## Chapter

## 1

## HISTORY

**General.**—Since antiquity, as various civilizations developed throughout the world of which we have any historical record, man has attached importance to the source and handling of his meat supply. From time to time this has included requirements, restrictions, and even taboos influenced by philosophies of diet, religious practices and their ritualistic ramifications. As civilization makes itself felt on groups of people, conscious efforts are made to separate themselves as far as possible from practices of savagery. They no longer are satisfied with being scavengers. The old testament, in Exod. *22*:31, reads "And ye shall be holy men unto me: neither shall ye eat any flesh that is torn of beasts in the field; ye shall cast it to the dogs."

**Hebraic.**—The quotation given above from Exodus is the Biblical command from which the Hebrews developed their Laws of Terephah; these laws give the conditions that render animals unacceptable for food. As

**כשר**

FIG. 1.—Hebraic characters signifying kosher.

contained in the Talmud, they constitute a sort of codification of traditional oral law which developed over many centuries of early Hebrew culture. These terephas or trefas, as the word is used today, are considered by the Hebrew ritual as defects which would make an animal affected by one or more of them subject to Biblical proscription. Originally, there were 18 kinds of trefas in the Mishnaic portion of the Talmud re-dated about 200 A. D. These were later grouped into 6 major categories. This is mentioned as an example of how detailed the interest of a people can become in the meat portion of its diet.

Alongside the negative law of trefa developed quite logically the positive law of kosher. Today, the word kosher is used, meaning ritually clean. It is significant that these so-called laws of trefa and laws of kosher have become so firmly established and so interwoven with the culture of the Hebrew race that they are still retained as part of the ritual of Hebrews residing in this country today. Rabbi and Rabbinical representatives

are present in many meat packing plants for the purpose of determining whether meat which is intended to be merchandised in the Jewish trade meets their ritualistic requirements. That meat which is found to be acceptable to them is marked with the characters shown in figure 1.

**Medieval Florentine.**—There comes to us in connection with the history of Florentine Guilds, specifically, the "arte de 'Beccai" or the Guild of Butchers, some information concerning controls exercised by Renaissance Florentines over their meat supply. It appears that, originally, the slaughtering and merchandising of meat in the city of Florence were pretty much monopolized by rich and powerful landholders who controlled large grazing lands. In spite of their effort to eliminate the middleman or local butcher from the meat merchandising field, as civil life became more complicated in that ancient city, butchers, as a class of artisans, came into being and this class eventually became a powerful guild.

Concurrent with this development, it became necessary for the city of Florence to pass laws aimed at the correction of unsanitary and fraudulent practices employed by some members of this guild. It appears that the guild members were not only very capable meat merchandisers but, judging from the number of law suits, they must have developed a certain amount of ability to defend themselves successfully in the courts.

The laws enacted by the city of Florence during the thirteenth and fourteenth centuries had a four-fold effect. They required that all butchers annually renew their licenses and at the same time pledge themselves to observing the law of the land. These laws prohibited many kinds of fraudulent practices consisting principally of misrepresentations and substitutions. They prohibited unsanitary practices, such as carelessness in the disposal of offal and unclean premises, and fined unskilled and untidy workmen. They also provided for appointing expert inspectors whose duty it was to detect and bring to court instances of fraud or other irregular practices prohibited by law.

This pattern of meat control served as a forerunner of the science of meat hygiene as it has developed in our western civilization. There only remained to fit into this scheme the science of veterinary medicine and adapt to current needs the controls relating to sanitation, adulteration, and misrepresentation. This has been, in fact, very effectively applied in some European countries for many generations.

**American.**—While the present meat inspection system dates back only half a century, the importance of animals' health in relation to a dependable meat supply has long been recognized. As a matter of fact, the first meat inspection law on this continent dates back to 1706. This was an act passed in New France which required butchers to notify an officer known as the Procureur du Roi whenever meat animals were slaughtered, so that he could attend to inspect the quality of the meat. Farmers bringing meat to town for sale were also directed to present a certificate from their local judge, seigneur or curé, certifying that it did not come from animals which had been sick, drowned or poisoned.

In colonial times the raising of livestock and the marketing of food animals was entirely a local enterprise. The slaughtering or, as it was then called, butchering of local animals supplied the meat bought by the house-

wives. These local butchers were identified closely with both the farmer who produced the food animals and the consumer of his meat products. This was particularly true of the relationship between the local butcher and his customers.

This close relationship between the local butcher in these early times and the consumer had a definite influence on the kind of butchering practices employed by this local forerunner of the present-day meat packer. The consumers' interest in a disease-free, clean and wholesome meat supply made itself felt on the local butcher. If he were to have a successful business, it was necessary for him to have the confidence of his customers. This required him to run a clean plant and to merchandise only wholesome, unadulterated products.

As this Nation developed in size, and systems of transportation covered the country, the livestock and meat industry shifted from a local enterprise to a national one. Livestock raising moved away from meat consuming areas. The local butchering establishments became retail shops which no longer slaughtered food animals but obtained their meats from large slaughtering plants located conveniently in the large livestock raising areas. The small slaughtering butcher found himself unable to compete economically with the large slaughtering plant which had the advantage of location convenient to livestock supplies and of volume production.

As these large meat packing plants changed the original pattern of local livestock and meat marketing, it became recognized that one of the changes was very closely identified with the consumer interests. By contrast with his success in influencing practices employed by the local butcher, the consumer had no opportunity to influence practices of the large meat packer as they related to sanitation, wholesomeness of product, and freedom from adulteration. It took a little while for consumer interest to crystallize. Actually, the meat inspection law passed in 1889 had for its purpose the protection of foreign trade in meat and meat products.

In the early 1880's American dressed beef and, later, American pork products became large factors in American export trade with certain foreign countries. For some years prior to 1890, there were circulated in these foreign countries rumors of the existence of diseases among our food-producing animals which, it was claimed, rendered the meat unfit for food. In 1889, the Secretary of Agriculture in his annual report urged the necessity of a national inspection of cattle at the time of slaughter which would secure the condemnation of carcasses unfit for food and guarantee the accepted product as untainted by disease.

In the first session of the 51st Congress, there was introduced in the Senate S.2594. This bill passed the Senate and was then considered by the House Committee of Agriculture. The committee recommended the passage of the bill on the ground that it was necessary to secure the removal of restrictions placed upon the importation of our meat by foreign countries. This bill, enacted into law by both Houses, was approved by the President on August 30, 1890. It did not provide for post-mortem inspection at time of slaughter. It provided only for an inspection of meats in the piece and then only when intended for exportation to countries, the

Governments of which required such inspection or whenever any buyer, seller, or exporter requested it.

The law failed of its purpose, however, for in the next annual report of the Secretary of Agriculture we find the Secretary urging the enactment of a law which provided for a national inspection of cattle at the time of slaughter.

The Secretary pointed out that none of the restrictions against the sale of American meats abroad had been removed and that, indeed, there was a tendency to make these restrictions more stringent and irksome.

In the report of the Chief of the Bureau of Animal Industry for the year 1891 occurs the following comment on the law of 1890: "The Act of Congress of August 30, 1890, provided for the inspection of salted pork and bacon. It was the intention of Congress in passing this measure to enact a law which would enable this government to so certify to the wholesomeness of our pork products that it would entitle them to enter into foreign countries. The provisions of this Act, however, referred more particularly to an inspection which would determine the character and manner in which these products were packed and their condition at time of shipment, and did not reach to the more important object of determining whether the animals from which they came were diseased or not at the time of slaughter." The consequence was that foreign governments refused to recognize such inspection or certificates issued thereunder as sufficient to warrant removal of the prohibition which they had for many years maintained against American pork.

In the reports of the Secretary of Agriculture and of the Chief of the Bureau of Animal Industry for the Fiscal Years 1891, 1893, 1894, and 1895 recommendations were made for amendments to the Meat Inspection Law aimed at strengthening its provisions. These recommendations resulted in the Acts of March 3, 1891, and March 2, 1895. These laws and their administration fell far short of satisfying the demands of the American public for an adequate national system of meat inspection.

In the spring of 1906 rumors gained credence that the packing houses of the country were not conducted in a sanitary manner and that the inspection under the Act of 1891, as amended by the Act of 1895, was not conducted in a thorough-going, efficient way. The Secretary of Agriculture appointed a Committee to investigate conditions at one of the large packing centers and the President of the United States appointed a Committee for the same purpose.

President Theodore Roosevelt on June 4, 1906, sent a message entitled "Conditions in Chicago Stockyards" to the Senate and House of Representatives. It reads as follows:

59TH CONGRESS 1st Session. } HOUSE OF REPRESENTATIVES. { DOCUMENT No. 873

# CONDITIONS IN CHICAGO STOCK YARDS.

MESSAGE

FROM THE

# PRESIDENT

TRANSMITTING

THE REPORT OF MR. JAMES BRONSON REYNOLDS AND COMMISSIONER CHARLES P. NEILL, SPECIAL COMMITTEE APPOINTED TO INVESTIGATE THE CONDITIONS IN THE STOCK YARDS OF CHICAGO.

June 4, 1906.—Read; referred to the Committee on Agriculture and ordered to be printed.

THE SENATE AND HOUSE OF REPRESENTATIVES:

I transmit herewith the report of Mr. James Bronson Reynolds and Commissioner Charles P. Neill, the special committee whom I appointed to investigate into the conditions in the stock yards of Chicago and report thereon to me. This report is of a preliminary nature. I submit it to you now because it shows the urgent need of immediate action by the Congress in the direction of providing a drastic and thoroughgoing inspection by the Federal Government of all stock yards and packing houses and of their products, so far as the latter enter into interstate or foreign commerce. The conditions shown by even this short inspection to exist in the Chicago stock yards are revolting. It is imperatively necessary in the interest of health and of decency that they should be radically changed. Under the existing law it is wholly impossible to secure satisfactory results.

When my attention was first directed to this matter an investigation was made under the Bureau of Animal Industry of the Department of Agriculture. When the preliminary statements of this investigation were brought to my attention they showed such defects in the law and such wholly unexpected conditions that I deemed it best to have a further immediate investigation by men not connected with the Bureau, and accordingly appointed Messrs. Reynolds and Neill. It was impossible under the existing law that satisfactory work should be done by the Bureau of Animal Industry. I am now, however, examining the way in which the work actually was done.

Before I had received the report of Messrs. Reynolds and Neill I had directed that labels placed upon any package of meat food products should state only that the carcass of the animal from which the meat was taken had been inspected at the time of slaughter. If inspection of meat food products at all stages of preparation is not secured by the passage of the legislature recommended, I shall feel compelled to order that inspection labels and certificates on canned products shall not be used hereafter.

The report shows that the stock yards and packing houses are not kept even reasonably clean, and that the method of handling and preparing food products is

uncleanly and dangerous to health. Under existing law the National Government has no power to enforce inspection of the many forms of prepared meat food product that are daily going from the packing houses into interstate commerce. Owing to inadequate appropriation the Department of Agriculture is not even able to place inspectors in all establishments desiring them. The present law prohibits the shipment of uninspected meat to foreign countries, but there is no provision forbidding the shipment of uninspected meats in interstate commerce, and thus the avenues of interstate commerce are left open to traffic in diseased or spoiled meats. If, as has been alleged on seemingly good authority, further evils exist, such as the improper use of chemicals and dyes, the Government lacks power to remedy them. A law is needed which will enable the inspectors of the General Government to inspect and supervise from the hoof to the can the preparation of the meat food product. The evil seems to be much less in the sale of dressed carcasses than in the sale of canned and other prepared products; and very much less as regards products sent abroad than as regards those used at home.

In my judgment the expense of the inspection should be paid by a fee levied on each animal slaughtered. If this is not done, the whole purpose of the law can at any time be defeated through an insufficient appropriation; and whenever there was no particular public interest in the subject it would not be only easy but natural to thus make the appropriation insufficient. If it were not for this consideration, I should favor the Government paying for the inspection.

The alarm expressed in certain quarters concerning this feature should be allayed by a realization of the fact that in no case, under such a law, will the cost of inspection exceed 8 cents per head.

I call special attention to the fact that this report is preliminary, and that the investigation is still unfinished. It is not yet possible to report on the alleged abuses in the use of deleterious chemical compounds in connection with canning and preserving meat products, nor on the alleged doctoring in this fashion of tainted meat and of products returned to the packers as having grown unsalable or unusable from age or from other reasons. Grave allegations are made in reference to abuses of this nature.

Let me repeat that under the present law there is practically no method of stopping these abuses if they should be discovered to exist. Legislation is needed in order to prevent the possibility of all abuses in the future. If no legislation is passed, then the excellent results accomplished by the work of this special committee will endure only so long as the memory of the committee's work is fresh, and a recrudescence of the abuses is absolutely certain.

I urge the immediate enactment into law of provisions which will enable the Department of Agriculture adequately to inspect the meat and meat food products entering into interstate commerce and to supervise the methods of preparing the same, and to prescribe the sanitary conditions under which the work shall be performed. I therefore commend to your favorable consideration and urge the enactment of substantially the provisions known as Senate amendment No. 29 to the act making appropriations for the Department of Agriculture for the fiscal year ending June 30, 1907, as passed by the Senate, this amendment being commonly known as the Beveridge amendment.

THEODORE ROOSEVELT.

THE WHITE HOUSE, *June 4, 1906.*

Following is the report made to President Roosevelt by Commissioner Charles P. Neill and Mr. James Bronson Reynolds.

THE PRESIDENT:

As directed by you, we investigated the conditions in the principal establishments in Chicago engaged in the slaughter of cattle, sheep, and hogs and in the preparation of dressed meat and meat food products. Two and a half weeks were spent in the investigation in Chicago, and during this time we went through the principal packing houses in the stock yards district, together with a few of the

smaller ones. A day was spent by Mr. Reynolds in New York City in the investigation of several of its leading slaughterhouses. During our investigation statements of conditions and practices in the packing houses, together with affidavits and documentary evidence, were offered us from numerous sources. Most of these were rejected as being far from proving the facts alleged and as being beyond the possibility of verification by us. We have made no statement as a fact in the report here presented that was not verified by our personal examination. Certain matters which we were unable to verify while in Chicago are still under investigation. The following is therefore submitted as a partial report touching upon those practices and conditions which we found most common and not confined to a single house or class of houses. A more detailed report would contain many specific instances of defects found in particular houses.

## I.—Conditions of the Yards.

Before entering the buildings we noted the conditions of the yards themselves as shown in the pavement, pens, viaducts, and platforms. The pavement is mostly of brick, the bricks laid with deep grooves between them, which inevitably fill with manure and refuse. Such pavement can not be properly cleaned and is slimy and malodorous when wet, yielding clouds of ill-smelling dust when dry. The pens are generally uncovered except those for sheep; these latter are paved and covered. The viaducts and platforms are of wood. Calves, sheep, and hogs that have died en route are thrown out upon the platforms where cars are unloaded. On a single platform on one occasion we counted 15 dead hogs, on the next 10 dead hogs. The only excuse given for delay in removal was that so often heard—the expense.

## II.—Buildings.

*Material.*—The interior finish of most of the buildings is of wood; the partition walls, supports, and rafters are of wood, uncovered by plaster or cement. The flooring in some instances is of brick or cement, but usually of wood. In many of the rooms where water is used freely the floors are soaked and slimy.

*Lighting.*—The buildings have been constructed with little regard to either light or ventilation. The workrooms, as a rule, are very poorly lighted. A few rooms at the top of the buildings are well lighted because they can not escape the light, but most of the rooms are so dark as to make artificial light necessary at all times. Many inside rooms where food is prepared are without windows, deprived of sunlight and without direct communication with the outside air. They may be best described as vaults in which the air rarely changes. Other rooms which open to the outer air are so large, the windows so clouded by dirt, and the walls and ceilings so dark and dingy that natural light only penetrates 20 or 30 feet from the windows, thus making artificial light in portions of even the outside rooms necessary. These dark and dingy rooms are naturally not kept suitably clean.

*Ventilation.*—Systematic ventilation of the workrooms is not found in any of the establishments we visited. In a few instances electric fans mitigate the stifling air, but usually the workers toil without relief in a humid atmosphere heavy with the odors of rotten wood, decayed meats, stinking offal, and entrails.

*Equipment.*—The work tables upon which the meat is handled, the floor carts on which it is carried about, and the tubs and other receptacles into which it is thrown are generally of wood. In all the places visited but a single porcelain lined receptacle was seen. Tables covered with sheet iron, iron carts, and iron tubs are being introduced into the better establishments, but no establishment visited has as yet abandoned the extensive use of wooden tables and wooden receptacles. These wooden receptacles are frequently found water soaked, only half cleansed, and with meat scraps and grease accumulations adhering to their sides and collecting dirt. This is largely true of meat racks and meat conveyors of every sort, which were in nearly all cases inadequately cleansed, and grease and meat scraps were found adhering to them even after they had been washed and returned to service.

*Sanitary conveniences.*—Nothing shows more strikingly the general indifference to matters of cleanliness and sanitation than do the privies for both men and women.

The prevailing type is made by cutting off a section of the workroom by a thin wooden partition rising to within a few feet of the ceiling. These privies usually ventilate into the workroom, though a few are found with a window opening into the outer air. Many are located in the inside corners of the work rooms, and thus have no outside opening whatever. They are furnished with a row of seats, generally without even side partitions. These rooms are sometimes used as cloakrooms by the employees. Lunch rooms constructed in the same manner, by boarding off a section of the workroom, often adjoins the privies, the odors of which add to the generally insanitary state of the atmosphere.

Abominable as the above-named conditions are, the one that affects most directly and seriously the cleanliness of the food products is the frequent absence of any lavatory provisions in the privies. Washing sinks are either not furnished at all or are small and dirty. Neither are towels, soap, or toilet paper provided. Men and women return directly from these places to plunge their unwashed hands into the meat to be converted into such food products as sausage, dried beef, and other compounds. Some of the privies are situated at a long distance from the workrooms, and men relieve themselves on the killing floors or in a corner of the workrooms. Hence, in some cases the fumes of the urine swell the sum of nauseating odors arising from the dirty-blood-soaked, rotting wooden floors, fruitful culture beds for the disease germs of men and animals.

*New buildings.*—It is stated that many of the unsanitary conditions are due to the fact that these buildings are old and have been built by piecemeal, and that in the newer buildings, being erected from time to time, the defects of the earlier structures are being remedied. This contention is not borne out by the facts. One of the larger plants erected within recent years has most of the defects of the older buildings. It is true that three large model buildings have been erected, but one is an office building, while the other two contain only cooling, storage, and sales rooms. No model building for the preparation of food products has been built in the stock yards of Chicago.

### III.—A Model Slaughterhouse in Contrast with Those of Chicago

In impressive contrast to the conditions that we saw in the stock yards of Chicago is an establishment that Mr. Reynolds visited in New York City. It well merits a description in those particulars in which it is vastly superior to similar concerns in Chicago. The two upper floors used for cattle pens are paved with well-laid bricks and cement, with side walls of brick, the top floor being covered to protect the cattle from the weather. The killing floor is paved with bluestone, sloping toward well-arranged drains, and has a large air shaft for special ventilation and abundant windows. The ceiling and upper side walls are of hard cement, with steel crossbeams and cement-faced steel supports. The lower side walls are covered with white porcelain brick. When the slaughtering of each day is finished, water is turned on, and in not more than fifteen minutes the room is so thoroughly cleansed that all perceptible odors and traces of the work are removed.

Other rooms, such as those for cooling and storage, are of similar construction to the killing floor. White porcelain-lined bricks and curved tiles join floor and side walls, that no corners may retain dirt and refuse. Ventilation is everywhere excellent and light abundant, both these matters having evidently received careful consideration in planning the building. The privies contain separate sections with self-flushing bowls, white porcelain-lined wash basins, shower baths, and mirrors. Towels and toilet paper are provided, and everything is kept clean. The effect of all these excellencies of construction and arrangement is evident in promoting the care of the products and in elevating the morals of the workers.

The same principles of sanitation and the same care of the health and cleanliness of the workers would revolutionize the stock yards of Chicago, and the attainment of such a standard should be the concern of the National Government and of the city of Chicago.

Under existing conditions the burden of protecting the cleanliness and wholesomeness of the products and the health of the workers and of improving the conditions under which the work is performed, must fall upon the National Government.

## IV.—Treatment of Meats and Prepared Food Products

*Uncleanliness in handling products.*—An absence of cleanliness was also found everywhere in the handling of meat being prepared for the various meat-food products. After killing, carcasses are well washed, and up to the time they reach the cooling room are handled in a fairly sanitary and cleanly manner. The parts that leave the cooling room for treatment in bulk are also handled with regard to cleanliness, but the parts that are sent from the cooling room to those departments of the packing houses in which various forms of meat products are prepared are handled with no regard whatever for cleanliness. In some of the largest establishments sides that are sent to what is known as the boning room are thrown in a heap upon the floor. The workers climb over these heaps of meat, select the pieces they wish, and frequently throw them down upon the dirty floor beside their working bench. Even in cutting the meat upon the bench, the work is usually held pressed against their aprons, and these aprons were, as a rule, indescribably filthy. They were made in most cases of leather or of rough sacking and bore long accumulated grease and dirt. In only a few places were suitable oilcloth aprons worn. Moreover, men were seen to climb from the floor and stand, with shoes dirty with the refuse of the floors, on the tables upon which the meat was handled. They were seen at the lunch hour sitting on the tables on the spot on which the meat product was handled, and all this under the very eye of the superintendent of the room, showing that this was the common practice.

Meat scraps were also found being shoveled into receptacles from dirty floors where they were left to lie until again shoveled into barrels or into machines for chopping. These floors, it must be noted, were in most cases damp and soggy, in dark, ill-ventilated rooms, and the employees in utter ignorance of cleanliness or danger to health expectorated at will upon them. In a word, we saw meat shoveled from filthy wooden floors, piled on tables rarely washed, pushed from room to room in rotten box carts, in all of which processes it was in the way of gathering dirt, splinters, floor filth, and the expectoration of tuberculous and other diseased workers. Where comment was made to floor superintendents about these matters, it was always the reply that this meat would afterwards be cooked, and that this sterilization would prevent any danger from its use. Even this, it may be pointed out in passing, is not wholly true. A very considerable portion of the meat so handled is sent out as smoked products and in the form of sausages, which are prepared to be eaten without being cooked.

A particularly glaring instance of uncleanliness was found in a room where the best grade of sausage was being prepared for export. It was made from carefully selected meats, and was being prepared to be eaten uncooked. In this case the employee carted the chopped-up meat across a room in a barrow, the handles of which were filthy with grease. The meat was then thrown out upon tables, and the employee climbed upon the table, handled the meat with his unwashed hands, knelt with his dirty apron and trousers in contact with the meat he was spreading out, and, after he had finished his operation, again took hold of the dirty handles of the wheelbarrow, went back for another load, and repeated this process indefinitely. Inquiry developed the fact that there was no water in this room at all, and the only method the man adopted for cleaning his hands was to rub them against his dirty apron or on his still filthier trousers.

As an extreme example of the entire disregard on the part of employees of any notion of cleanliness in handling dressed meat, we saw a hog that had just been killed cleansed, washed, and started on its way to the cooling room fall from the sliding rail to a dirty wooden floor and slide part way into a filthy men's privy. It was picked up by two employees, placed upon a truck, carried into the cooling room and hung up with other carcasses, no effort being made to clean it.

*Treatment of meat after inspection.*—The radical defect in the present system of inspection is that it does not go far enough. It is confined at present by law to passing on the healthfulness of animals at the time of killing; but the meat that is used for sausage and in the various forms of canned products and other prepared meat foods goes through many processes, in all of which there is possibility of contamination through insanitary handling, and further danger through the use of

chemicals. During all these processes of preparation there is no Government inspection and no assurance whatever that these meat-food products are wholesome and fit for food despite the fact that all these products, when sent out, bear a label stating they have been passed upon by Government inspectors.

As to the investigation of the alleged use of dyes, preservatives, or chemicals in the preparation of cured meats, sausages, and canned goods we are not yet prepared to report. We did look into the matter of sanitary handling of the meats being prepared for the various food products. The results of our observations have already been partly given. Other instances of how products may be made up, and still secure the stamp of Government inspection are here given. In one well-known establishment we came upon fresh meat being shoveled into barrels, and a regular proportion being added of stale scraps that had lain on a dirty floor in the corner of a room for some days previous. In another establishment, equally well known, a long table was noted converted with several hundred pounds of cooked scraps of beef and other meats. Some of these meat scraps were dry, leathery, and unfit to be eaten; and in the heap were found pieces of pigskin, and even some bits of rope strands and other rubbish. Inquiry evoked the frank admission from the man in charge that this was to be ground up and used in making "potted ham."

All of these canned products bear labels of which the following is a sample:

ABBATTOIR NO.—.

The contents of this package have been inspected according to the act of Congress of March 3, 1891.

QUALITY GUARANTEED

The phraseology of these labels is wholly unwarranted. The Government inspectors pass only upon the healthfulness of the animal at the time of killing. They know nothing of the processes through which the meat has passed since this inspection. They do not know what else may have been placed in the cans in addition to "inspected meat." As a matter of fact, they know nothing about the "contents" of the can upon which the packers place these labels—do not even know that it contains what it purports to contain. The legend "Quality guaranteed" immediately following the statement as to Government inspection is wholly unjustifiable. It deceives and is plainly designed to deceive the average purchaser, who naturally infers from the label that the Government guarantees the content of the can to be what it purports to be.

In another establishment piles of sausages and dry moldy canned meats, admittedly several years old, were found, which the superintendent stated to us would be tanked and converted into grease. The disposition to be made of this was wholly optional with the superintendents or representatives of the packers as the Government does not concern itself with the disposition of meats after they have passed inspection on the killing floor. It might all be treated with chemicals, mixed with other meats, turned out in any form of meat product desired, and yet the packages or receptacles in which it was to be shipped out to the public would be marked with a label that their contents had been "Government inspected." It is not alleged here that such use was to be made of this stuff. The case is pointed out as one showing the glaring opportunity for the misuse of a label bearing the name and the implied guaranty of the United States Government

Another instance of abuse in the use of the labels came to our notice. In two different establishments great stocks of old canned goods were being put through a washing process to remove the old labels. They were then subjected to sufficient heat to "liven up" the contents—to use the phrase of the room superintendent. After this, fresh labels, with the Government name on them, were to be placed upon the cans, and they were to be sent out bearing all the evidence of being a freshly put up product. In one of these instances, by the admission of the superintendent, the stock thus being relabeled was over two years old. In the other case the superintendent evaded a statement of how old the goods were.

## V.—Treatment of Employees.

The lack of consideration for the health and comfort of the laborers in the Chicago stock yards seems to be a direct consequence of the system of administration that prevails. The various departments are under the direct control of superintendents who claim to use full authority in dealing with the employees and who seem to ignore all considerations except those of the account book. Under this system proper care of the products and of the health and comfort of the employees is impossible, and the consumer suffers in consequence. The insanitary conditions in which the laborers work and the feverish pace which they are forced to maintain inevitably affects their health. Physicians state that tuberculosis is disproportionately prevalent in the stock yards, and the victims of this disease expectorate on the spongy wooden floors of the dark workrooms, from which falling scraps of meat are later shoveled up to be converted into food products.

Even the ordinary decencies of life are completely ignored. In practically all cases the doors of the toilet rooms open directly into the working rooms, the privies of men and women frequently adjoin, and the entrances are sometimes no more than a foot or two apart. In other cases there are no privies for women in the rooms in which they work, and to reach the nearest it is necessary to go up or down a couple of flights of stairs. In one noticeable instance the privy for the women working in several adjoining rooms was in a room in which men chiefly were employed, and every girl going to use this had to pass by the working places of dozens of male operatives and enter the privy the door of which was not 6 feet from the working place of one of the men operatives. As previously noted, in the privies for men and women alike there are no partitions, but simply a long row of open seats. Rest rooms, were tired women workers might go for a short rest, were found as rare exceptions, and in some establishments women are even placed in charge of privies chiefly for the purpose, it was stated, to see that the girls did not absent themselves too long from their work under the excuse of visiting them. In some instances what was called a rest room was simply one end of the privy partitioned off by a 6-foot partition from the remaining inclosure. A few girls were found using this, not only as a rest room, but as the only available place in which to sit and eat their luncheon.

Much of the work in connection with the handling of meat has to be carried on in rooms of a low temperature, but even here a callous disregard was everywhere seen for the comfort of those who worked in these rooms. Girls and women were found in rooms registering a temperature of 38° F., without any ventilation whatever, depending entirely upon artificial light. The floors were wet and soggy, and in some cases covered with water, so that the girls had to stand in boxes of sawdust as a protection for their feet. In a few cases even drippings from the refrigerator rooms above trickled through the ceiling upon the heads of the workers and upon the food products being prepared. A very slight expense would have furnished drier floors and protected them against the tricklings from the ceiling. It was asserted by the superintendent of these rooms that this low temperature was essential to the proper keeping of the meat; but precisely similar work was found in other establishments carried on in rooms kept at a fair temperature. In many cases girls of 16, 17, and 18 years stand ten hours a day at work, much of which could be carried on while sitting down.

In several establishments well managed restaurants were provided for the clerical force, and in one instance a smoking room was provided for them; but no provision was found anywhere for a place to eat for the male laborers. In pleasant weather they eat their luncheon sitting outdoors along the edge of the sidewalk, or any place where they can find standing room. In winter, however, and in inclement weather, their lunches have to be eaten in rooms that in many cases are stifling and nauseating. Eating rooms are provided in a number of places for women workers in the various departments; and in most of the large establishments coffee is served them at a penny a cup. Beyond this meager consideration for their convenience at meal times, scarcely any evidence is found that anyone gave a thought to their comfort.

The neglect on the part of their employers to recognize or provide for the requirements of cleanliness and decency of the employees must have an influence that can not be exaggerated in lowering the morals and discouraging cleanliness on the part

of the workers employed in the packing houses. The whole situation as we saw it in these huge establishments tends necessarily and inevitably to the moral degradation of thousands of workers, who are forced to spend their working hours under conditions that are entirely unnecessary and unpardonable, and which is a constant menace not only to their own health, but to the health of those who use the food products prepared by them.

### VI.—Government Inspection.

We observed carefully the inspection before slaughter, the inspection after slaughter on the killing beds, the more minute examination of animals tagged on the killing floors, and the microscopic examination for trichinosis.

*Inspection before slaughter.*—Inspection before slaughter appears to have little value in most cases. That undue advantage of this inspection is taken by outside parties is charged, and opportunities for such are abundant, but no specific evidence was presented to us. That this unimportant and superficial examination should be compulsory under the present law, whereas the more scientific examination after slaughter is only permissive, indicates a serious defect in the law.

*Inspection after slaughter.*—Inspection after slaughter appears to be carefully and conscientiously made. The Government veterinarians maintain that it is adequate, insisting that a passing examination of certain glands, of the viscera, and of the general conditions of the carcass is sufficient to enable an expert, engaged constantly on this work, to detect at once the presence of disease, or of abnormal conditions. On the slightest indication of disease or abnormal conditions the carcass is tagged and set aside for a later and more careful examination. There should, however, be more precautions taken to insure that the instruments used be kept antiseptically clean.

*Microscopic examination.*—The microscopic examination of hogs to be exported to Germany appears to be made with great care, and it may fairly be asked why the same inspection is not made of hogs killed for the American market. The statement that ham, pork, and sausage, that are frequently eaten raw in Germany, are not so used in America, is not strictly true. Large numbers of our foreign-born population eat ham and pork comparatively raw, and hence need this protection; and further, much of this pork goes into sausage to be eaten without being cooked.

*Number of inspectors.*—The present number of inspectors is certainly inadequate, as the Secretary of Agriculture has often complained. We noted that some large establishments had an obviously insufficient force. A few small concerns had no inspectors at all, and may sell uninspected meat wherever they please in the United States.

### VI.—*Legislation.*

1. Examination before slaughter is of minor importance and should be permissive instead of mandatory. Examination after slaughter is of supreme importance and should be compulsory.

2. Goats, now exempt from inspection, intended for foreign or interstate commerce, should be included in the list subject to the inspection of the Bureau of Animal Industry and should be equally controlled by the Secretary of Agriculture.

3. The examination of all meat products intended for interstate commerce at any stage of their care or treatment should be consigned to the Bureau of Animal Industry and no mark or sign declaring that inspection has been made by Government officials should be allowed on any can, box, or other receptacle or parcel containing food products unless the same has been subject to Government inspection at any and every stage of the process of preparation, and all such labels should contain the date of issuance, and it should be a misdemeanor to erase, alter or destroy any such labels. Meat products, and canned, preserved, or pickled meats, when sent from any packing or canning establishment, if returned to the same, should be subject to such further inspection, regulation, and isolation from other meat products as the Secretary of Agriculture may prescribe.

4. Power should be given to the Secretary of Agriculture to make rules and regulations regarding the sanitation and construction of all buildings used or intended to be used for the care of food products for interstate or foreign trade, and to make such regulation as he may deem necessary to otherwise protect the cleanliness and wholesomeness of animal products, prepared and sold for foreign and interstate commerce.

5. It should be forbidden to any person, firm, or corporation to transport or offer for transportation from one State to another any meat or meat food products not inspected or labeled.

*General suggestions.*—1. The number of inspectors should be largely increased, so that special assignments may be made for night inspection, for the examination of animals at the platforms of stock yards, for the following of dead animals to their alleged destination, and for other special work.

2. Special Government inspection should be carried on continuously to prevent violations of the law and general abuse in the trade, and to secure evidence when necessary.

3. A careful study of the standards of inspection in other countries should be made, and the results of the study should be published and circulated for the public information.

4. Consideration should be given to the question of specific labeling of all carcasses sold as fresh meat, which upon examination after slaughter, show signs of disease, but are still deemed suitable for food.

James Bronson Reynolds.
Chas. P. Neill.

Washington, D. C., *June 2, 1906.*

This brought about the enactment of a comprehensive meat inspection law which was passed June 30, 1906 (p. 505 Appendix). The organization of the Federal Meat Inspection Service under this law is covered in Chapter 17, page 465.

**Poultry.**—"Poultry was a 'Sunday dinner' specialty in 1906 when the Meat Inspection Act was passed and poultry was not covered by that Act. It continued to be a minor meat product for many years. Until relatively recently the bulk of poultry was bought by the consumer either live from the farmer-producer or from a produce house, or New York dressed (only blood and feathers removed). The housewife eviscerated and finally prepared the product for cooking observing firsthand if there were abnormalities, spoilage, or evidence of unwholesomeness." This quotation is taken from the report on "Compulsory inspection of poultry" of the subcommittee on legislation affecting the Food and Drug Administration of the Committee on Labor and Public Welfare, United States Senate 85th Congress, 2nd Session.

During the early 1920's there developed a very large traffic in live poultry from producing points to distribution points many miles away. These poultry were transported in specially constructed railroad cars, sometimes referred to as "palace" cars.

In 1924 an outbreak of fowl plague in the New York Central Railroad Yards on West Manhattan, New York City, used as a large poultry distribution point, focused attention on the magnitude of poultry shipment and its sanitary implication. The disrupting effect of this outbreak of fowl plague on Manhattan poultry supply resulted in the organization of a live poultry examination program by the New York Live Poultry Commission Association. This program was taken over by the United States Depart-

ment of Agriculture following an agreement dated November 15, 1926, and entered into by that Department with the New York Live Poultry Commission Association and the Greater New York Live Poultry Chamber of Commerce. This disease outbreak in the New York Central Yards and all of its ramifications as it had a bearing on the wholesomeness of the poultry meat supply in the New York City metropolitan area focused attention on the necessity for having the examination or inspection program extended to include dressed poultry and edible products derived therefrom. On November 16, 1928 the agreement entered into two years earlier was amended to include the inspection of dressed poultry and edible products for condition and wholesomeness.

As with so-called red meats, export trade also was a factor in the development of poultry inspection. In 1927 the United States Department of Agriculture and the Board of Health of the City of Camden, New Jersey, entered into an agreement whereby the Department of Agriculture conducted a poultry inspection service to cover exports to Canada.

Following the example of the City of New York, other cities passed ordinances that excluded poultry and poultry products other than those that had been inspected by the poultry inspection program of the United States Department of Agriculture. Poultry processors who wanted to ship their products into these cities requested the Department's inspection service. The poultry inspection program resulting from this development came to be known as the voluntary poultry inspection provided by the United States Department of Agriculture.

The inspection program was referred to as being a voluntary one because there was no Federal law that required poultry products to be inspected before they may be shipped interstate. This program was extended to approximately 150 poultry processing plants up until the late 1940's when during the next five years the number of inspected plants more than doubled.

This same five-year period witnessed a marked increase in the public interest in a mandatory national poultry inspection program that would apply to all poultry processors subject to Federal jurisdiction. Many bills were introduced during the 84th Congress and hearings held by Committees in connection with these bills reflected a mounting public interest in Federal legislation that would provide compulsory inspection of poultry.

These bills are worded to provide for the compulsory inspection by the United States Department of Agriculture of poultry and poultry products. The "legislative findings" read "Wholesome poultry products are an important source of the nation's total supply of food. Such products are consumed throughout the nation and substantial quantities thereof move in interstate and foreign commerce. Unwholesome and adulterated poultry products in channels of interstate and foreign commerce are injurious to the public welfare, adversely affect the marketing of wholesome poultry products, result in sundry losses to producers, and destroy markets for wholesome poultry products. The marketing of wholesome poultry products is affected with the public interest and directly affects the welfare of the people."

The following quotation from remarks of Senator Wayne Morse in the Senate of the United States on July 27, 1956, gives some idea of the public interest in the subject.

## Compulsory Inspection of Poultry

REMARKS

OF

# HON. WAYNE MORSE

OF OREGON

IN THE SENATE OF THE UNITED STATES

*Friday, July 27, 1956*

Mr. Morse. Mr. President, there is another matter on which I wish to comment. Then I shall ask unanimous consent to have printed in the Record a speech which I had intended to deliver today, but which I postponed in order to accommodate the schedule of the majority leader. It involves the serious matter of psittacosis, or parrot fever.

My proposal seeks to provide for the compulsory inspection of poultry. The health of the American people is being greatly jeopardized because of the inadequate inspection of poultry.

Only a few days ago we read that several persons in Ypsilanti, Mich., became ill after eating diseased poultry.

Mr. President, a poultry inspection bill should have been passed.

I ask unanimous consent to have printed in the Record the speech I intended to give today.

There being no objection, the address was ordered to be printed in the Record, as follows:

### Consumers, Industry, and Workers' Need Compulsory Poultry Inspection

The adjournment of Congress will leave unresolved one of the most vital problems of consumer protection to come before us in recent years. I am referring to legislation for the compulsory inspection of poultry.

It is highly unfortunate that neither the Senate nor the House of Representatives has acted on this most pressing legislation during the current session. Extremely dangerous problems to the health of consumers and poultry workers and to the economic welfare of the poultry industry are posed by the marketing of filthy and diseased poultry.

We, in Oregon, know through bitter experience how great are these health hazards and the need for compulsory poultry inspection. As I have reported to the Senate in detail previously, the Portland area of Oregon suffered a serious tragedy last spring because of the unhindered flow of diseased poultry. Two persons died and 62 men and women were made extremely ill—some were hospitalized for months by an epidemic of turkey-caused psittacosis or parrot fever.

#### A NATIONAL PROBLEM

Oregon is by no means the only area plagued by outbreaks of illness due to diseased poultry. For example, only on Wednesday, the Washington Daily News reported that dozens of Michigan college students had been hospitalized after eating poultry. The news account stated, and I quote: "Health officials in Ypsilanti, Mich., said that the sudden fever and nausea that hospitalized 40 Eastern Michigan College students was 'salmonella nurium' caused by infected poultry, and is 'very distressing, but almost never fatal.'"

These are just two of many outbreaks in recent years of illness, and sometimes death, caused by some of the 26 diseases transmissible from poultry to man. In Oregon, Texas, Michigan, Georgia, Nebraska, New Jersey, Virginia, Iowa, and other States unfit poultry has stricken consumers and poultry workers.

Despite the cries of apologists, diseased and adulterated poultry is definitely a health hazard. The very fact that poultry is in the unenviable position of the top category of causes for food poisoning demonstrates that point. The United States Public Health Service blames poultry and poultry products for an average of one-third of the food-poisoning cases reported each year. That percentage is far above those attributed to any other food groups, including all other perishables.

But even if death and illness were not involved here, even if consumers and poultry workers were not endangered, we would still have the responsibility to stem the flow of filthy and diseased poultry to market. The consumer does not want to buy garbage. And she has the right to be protected from buying it unwittingly. We must provide legislation which will assure her of good, clean, healthful birds.

INSPECTION NEED PROVEN

This great need for compulsory inspection legislation has been thoroughly documented in hearings before three different committees of Congress this year. But, unfortunately, this extensive consideration of the problem has not led to legislation.

The Senate Agriculture Committee last week reported what it called a compulsory poultry inspection bill. But the effectiveness of this measure is very doubtful. For example, it does not require ante mortem, or before slaughter, inspection, which alone probably would have prevented upward from 50 of the 64 Oregon cases of psittacosis. In fact, the Agriculture Committee's bill is a weak measure, loaded with loopholes.

Such legislation is as harmful to the poultry industry as to consumers. For poultry-inspection legislation without teeth cannot prevent epidemics. And future outbreaks will severely hurt the industry, in addition to causing human suffering.

OREGON HAS A DIRECT INTEREST

We, in Oregon, know that if there is a repetition of the spring disaster in our State, or if another poultry-caused disease were to strike there, our turkey industry would be severely harmed—and probably permanently so. Only the combined quick action of public-health authorities, labor, and industry saved the situation from becoming chaotic after the spring psittacosis outbreak. In the future, even this effective joint activity may not be enough against the resultant drop in consumer confidence and the embargoes of other States.

PUBLIC INTEREST GROUPS PIONEER

*Mr. President, we simply must have truly health-protective poultry-inspection* legislation. I know that the fight for it will continue and that it will be successful. Powerful public-health groups, women's organization, consumer groups, farm organizations and labor unions will increasingly press their joint effort to secure adequate and effective poultry inspection.

I want to thank and congratulate these groups for their fortitude and sense of public service.

Special credit must go to organized labor for the activities of the Amalgamated Meat Cutters and Butcher Workmen (AFL-CIO) in spearheading the campaign. This union called the attention of Congress and the Nation to the scandalous conditions existing in some sections of the poultry processing industry and to the problems these conditions posed to consumer and poultry workers.

For this public service I want to commend the Amalgamated Meat Cutters and Butcher Workmen and their great president and secretary-treasurer, Earl W. Jimerson and Patrick E. Gorman. I believe the Nation is indebted to them for their immense efforts to put this legislation on the books. The Meat Cutters Unions' campaign is, indeed, a wonderful example of a powerful organization using its strength to benefit all the people of the Nation.

The General Federation of Women's Clubs, Young Women's Christian Association, American Association of University Women, and Housewives United also

deserve great praise for their public-spirited campaign on behalf of this legislation. These women's groups have ably represented the views of homemakers and consumers.

The National Farmer's Union has made many valuable contributions during the consideration of the poultry inspection bills. It realizes the great benefits to farmers of legislation which will assure consumer confidence in an agricultural product.

And important health groups, the Association of State and Territorial Health Officers, Association of Food and Drug Officials of the United States, Association of State Public Health Veterinarians, Conference of Public Health Veterinarians, American Veterinary Medical Association, and American Nurses Association have aided Congress with their expert knowledge and support. Some members of these groups are really the pioneers in the campaign, for some have called for this legislation as far back as a decade ago.

**Poultry Inspection Bills.**—Extensive hearings were held by both a House Committee and a Senate Committee at which all interested parties were invited to comment on the proposed poultry inspection legislation. As the hearings progressed, all parties gradually arrived at an agreement that a poultry inspection law enacted by the Federal Congress not only would serve the American consumer but would benefit the poultry producer and the poultry packer. The Federal Meat Inspection Law came in for a good deal of attention during the hearings and there was general agreement that a poultry inspection law should provide inspection coverage similar to the Meat Inspection Law.

For a while there was some disagreement as to whether the poultry inspection legislation should include a provision for ante-mortem inspection. It was pointed out that even in the Meat Inspection Law the ante-mortem provision is not mandatory. Quoting from the Meat Inspection Law, it was shown that the Secretary was given discretion as to whether ante-mortem inspection would be conducted while all the other provisions of the law are couched in "shall" language. A lively discussion ensued on this point, however, testimony of qualified witnesses was convincing that ante-mortem inspection is essential to assuring that only healthy birds will be brought into the poultry processing plants. The proponents of ante-mortem inspection prevailed and the law containing this provision was finally signed by President Eisenhower on August 28, 1957 (Appendix, p. 510).

## Chapter
## 2

# ELEMENTS OF MEAT HYGIENE

MEAT hygiene is a branch of the larger subject of food hygiene, both having objectives in common. The methods necessary to be used in attaining these objectives for meat differ considerably from those considered to be adequate for most other kinds of food. Animals and poultry are subject to disease and other afflictions which make them unfit for use in the preparation of human food. It is not enough that the meat which is offered to the consumer for purchase as food appears to be normal. He expects to get meat which is produced from healthy animals and poultry under conditions which will assure elimination of diseased material and freedom from contamination and adulteration. Meat hygiene is distinguished by the methods that are necessary to be employed to accomplish this.

It is common knowledge that the application of the principles of meat hygiene cannot be entrusted to butchers and similar personnel employed by packing houses since they are primarily concerned with production problems, profits, and other interests not always consistent with good practices of food handling. Furthermore, animals, poultry, and slaughterhouses being what they are, it is imperative that each step in the dressing of the carcass and related activities receives the personal attention of a trained inspector.

**Ante-Mortem Inspection.**—The health of the animals and poultry is of initial concern. Examinations are made of each animal prior to slaughter for the purpose of eliminating those which are unfit for the preparation of food.

**Post-Mortem Inspection.**—The carcass of each animal and bird passed for slaughter is examined to eliminate it or any part of it if diseased or otherwise unfit. Many diseased and otherwise unfit conditions affecting animals and poultry are not detectable on ante-mortem examination. A careful post-mortem examination is therefore necessary. Possible sources of contamination which attend a dressing operation are eliminated or controlled. Unclean equipment, hides, skin, feet, feathers, diseased materials and the contents of sinuses, digestive tract, uro-genital tract, and the udder are ever-present sources of contamination attending the dressing of carcasses of food animals.

**Reinspection.**—As the meat leaves the slaughtering department it is only starting on its way to the consumer. Continued inspection supervision is conducted to assure its remaining clean and wholesome during its handling and manufacture into a great variety of food products. This supervision guards against contamination of the meat. It is a control against adulteration and misrepresentation. Also, it eliminates from the food supply meat which is unfit, adulterated, or misrepresented.

**Sanitation.**—This begins in the livestock and poultry pens and is a factor during each step in the handling of food animals, poultry, their carcasses, and the meat derived therefrom until it reaches the consumer. This is sometimes referred to as environmental sanitation. As the term implies, attention is given to every detail in the environment where meat is handled. This includes many of the structural aspects of the premises, water supply, sewage disposal, equipment of all kinds, personnel employed in the handling and preparation of the meat, and all similar details making up the environment to which the meat is subjected.

**Condemnation and Destruction of Unfit Materials.**—The detection of unfit animals, poultry, carcasses and parts, and meat products is followed by their immediate condemnation by an inspector, and they are then promptly destroyed for food purposes under his supervision.

**Adulteration.**—Nothing should be added to the meat during its handling and preparation which might impair its wholesomeness. Neither should any substance be added which is not normal to, or which is not expected by the consumer to be an ingredient of, a particular meat product.

**Misrepresentation.**—The meat as it is prepared for purchase by the consumer should not bear any mark or label which is misleading. Neither should it be packaged in a way that would be misleading as to its identity, quality, or quantity.

**General.**—It is of more than passing interest that the agency selected for the administration of the meat control legislation both in 1891 and in 1906 was and still is located in the U. S. Department of Agriculture. The agency selected had the formal designation of Bureau of Animal Industry and it was in effect the federal veterinary service.

The veterinarians who were given the responsibility to administer the Federal Meat Inspection Law accepted the total program identified in the legislation and proceeded to organize it so as to give full effect to the legislative coverage. They were not surprised to find that the new law covered considerably more than a regard for human health. In fact, from their experiences in dealing with meat production in the industry between the years 1891 and 1906 and their exposure to expressions of public opinion and interest, they would have been surprised if the new law had confined itself solely with a concern for human health. These veterinarians who organized the meat hygiene program under the law of 1906 had the advantage of several things. The consumer interest was clearly displayed in public expressions during that period. They also had vivid memories of the frustrating experiences that attended their efforts to administer inadequate meat inspection legislation during the 1891-1906 period.

Adequate ante-mortem and post-mortem routines are obvious to anyone as essential elements of a meat hygiene program. In fact, they characterize meat control programs by contrast with other programs of food control. They have received so much attention that they tend to overshadow the other essential elements of the program of meat hygiene as it has been developed and administered to satisfy the total consumer interest. Even these ante-mortem and post-mortem routines frequently have not been fully understood in terms of their objectives. There is an inclination to think of these routines as being concerned only with human health. They,

of course, have human health as one of their primary objectives but these routines are calculated to satisfy a broader consumer interest. It does not take much of a consumer survey to reveal clearly that the consumer demands normal, clean meat tissue for his dollar. Normal does not only mean that the product will not produce sickness. The consumer knows there are many loathesome conditions affecting animals which are not, in fact, transmissible to man. He insists that all of these loathesome conditions be eliminated from his food supply. Similarly, the meat must be clean. It is not enough that it is sterile and will not make him sick. It would be foolhardy to attempt to justify the inclusion of sterilized filth in the consumers' food supply.

When the term "consumer protection" is used to identify the objectives of a program of meat hygiene, it must be given the meaning that accords with consumer interest. Were consumer protection to be considered only in terms of human health, the control program would fall far short of consumer interest and it could not expect to have public confidence.

The consumer protection contemplated by meat inspection legislation goes beyond protection of human health to include protecting the consumer in his demands for the observance of common decency in the production and distribution of his meat supply. The consumer is protected against adulteration both as to harmful and unexpected ingredients. He is protected against mislabeling. He is protected against the use of improper methods in the production of meat food products and in their distribution.

The veterinarian is given the duty to discharge full responsibility in all of these areas of program coverage. The biological controls which come significantly in the area of veterinary competency are so interwoven with the total control picture in administering the program that the veterinarian logically is selected to be given full administrative responsibility. This means that the veterinarian acquires competency in the total field. He becomes enough of a packinghouse architect to review and evaluate meat packing plant construction and facilities as they relate to the inspection routines and proper handling of product. He knows as much about the products of the packing industry as a plant superintendent. He knows what it takes to evaluate effectively proposals for the use of new additives. He knows how to go about prescribing a standard of identity for a meat product. He familiarizes himself with all aspects of fair trade practice in his review of labeling material. He knows how to handle an organization, maintain sound working relationships with industry, and keep good public relations.

Reviewing plant facilities to determine their adequacy for operation under a meat hygiene program is a complicated and involved process. It means identifying standards for a long list of structural, layout, and equipment facilities. To do this requires the reviewing officer to know as much about the operation of a packing plant as a packing plant architect, and to be able to take the lead in adapting new and better facilities and materials to packinghouse operation. When a good job is done, real contributions are made in the interest of both the public and industry.

Product control aimed at assuring the use of methods of preparation that will in no way effect the wholesomeness of the product requires full

knowledge of manufacturing methods used by industry. Manufacturing methods are neither uniform as between plants nor static in application. There is a normal tendency to vary preparation methods for the same product as it is produced throughout industry. Also, members of industry are continually experimenting with changes and methods with the objective of making their respective products more competitive.

The "additive" subject is an important one. The packing industry is resourceful and enterprising, and it is working constantly in pilot plants trying out materials of all descriptions that might have usefulness in the wide range of industry's products. Actually, the industry participates in investigations made by other food industries and the many commercial chemical and biological laboratories. Under the meat hygiene program an inspected packer who wants to use a new additive is entitled to know promptly whether the additive is acceptable, and, if not acceptable, he is informed fully in what respect it fails to meet the requirements. New additives cannot be rejected arbitrarily. A standard of acceptance is applied to a proposal to use a new additive, and the standard uses only those criteria that can be demonstrated as being necessary to safeguard the consumer. Inspection programs are constantly reminded that they must not impose restrictions unnecessarily in the way of progress. The test required of a new additive to assure its harmlessness is justified in terms of necessity to attain that objective. It is required to be demonstrated that the additive serves a useful purpose. Furthermore, investigations must be conducted to make sure that even though the proposed additive is harmless as intended to be used, it will not result in adulteration or concealment of inferiority.

Standards of identity for foods have also come in for a good deal of attention since the inclusion of such authority in the Food and Drug Act of 1938. Actually, the authority has been included right along in meat inspection legislation even though it has only been used to any significant extent in recent years. The routine that is applied in setting up a standard of identity for a meat food product is detailed and exacting. The keynote is to identify what is called consumer expectancy with respect to the meat product for which the standard is to be prescribed. Consumer expectancy can only be demonstrated by collecting that amount of factual material that can be depended on to come up with a clear finding. This is essential because all parties affected by the standard have an opportunity to, and frequently do, challenge the decision. Challenges might be received from many sources including consumer groups, industry groups, and even other control agencies.

Label review is probably the most demanding of any of the responsibilities undertaken by the veterinarian in charge of a meat hygiene program. All of the sales, advertising, and merchandising talents of a great industry including some of the best in the business are reflected in the wording, design, and makeup of labels as they are presented for approval. Every conceivable word usage and design calculated to sell the product is evaluated in terms of truthful labeling, and the administration of this phase of the program requires a knowledge and application of every fair trade practice concept.

Even with all this technical competency, the program's success depends

on a number of intangibles. For example, the meat inspection organization with its far-flung assignment of personnel functions effectively only if every man is dedicated to his work, is loyal, and is of high integrity. A plan of supervision for meat inspection personnel is worked out and applied intelligently to accomplish these results. When industry subject to the inspection control has confidence in the program as it is applied to its operation, unnecessary friction and controversy are avoided. The program is applied uniformly at all plants subject to the inspection control. The inspection program makes every effort to acquire a reputation for honesty and fair dealing.

Good public relations are just as important in this enterprise as in all others that are organized in the public interest and rely on receiving public support.

The foregoing emphasizes aspects of the meat hygiene program that do not in all cases have a direct relation to human health. The ante-mortem and post-mortem inspection routines and the sanitation controls that are geared to the protection of human health constitute, of course, the keystone of the program. These routines are constantly under review to assure their effectiveness. Under constant review are investigations that are made throughout the world which relate to chemical and biological questions that have a bearing on food and its relation to human health.

A number of very substantial demands on a food control veterinarian involving important responsibilities have been stressed, with only casual mention of those that are usually considered as being in the field of the basic veterinary sciences. Actually, the application of these sciences to the objectives of a meat hygiene program is essential. Anatomy, pathology, histopathology, physiology, parasitology, biochemistry, and bacteriology are the obvious ones. The veterinarian soon finds, however, that with the exception of anatomy, these subjects must be re-learned and given a food control application if he is to use them intelligently.

The food control veterinarian is amazed when he finds that he should know everything about subjects that are not too well understood. For example, he must learn all he can about the biology, chemistry, and enzymology of muscle, fat, and connective tissue as meat. He does this because industry's scientists use their knowledge of these subjects in developing new products and to promote the use of many additives.

Reports of investigations in the fields of pathology, bacteriology, and parasitology are evaluated in terms of meat products and the consumer's interest. The food control veterinarian finds that investigations in these fields are rarely directed toward his interest. Investigation in a disease entity is usually focused on clinical interests or research which has a clinical application. When an incidental human food interest arises in connection with such investigation, it is usually expressed as a philosophy or hypothesis. Such material might contain significant leads for the food control veterinarian but he must evaluate these expressions in terms of his ability to apply them to his food control responsibility.

Chapter

# 3

## ANTE-MORTEM INSPECTION

COMPETENT ante-mortem inspection gives the only assurance that unfit animals and poultry will be handled in the fertilizer plant rather than processed as food. It is well known that sometimes stock raisers will ship sick animals for slaughter for food. Furthermore, many conditions develop while they are in transit to meat packing plants which might make the difference between profit and loss in a carload. It is only through the diligence of the ante-mortem inspector that unfit animals and poultry are kept out of departments where carcasses are handled in the course of their preparation as human food.

**Animals.—General.**—In order that the ante-mortem inspection can be conducted properly it is necessary to have adequate facilities. The animals are placed in properly lighted holding pens where the inspector can move freely among them and view them both at rest and in action. Equipment is provided for restraining those animals which the inspector requires to be segregated for closer examination and for such identification as he may consider to be necessary.

The animals that are found to be affected by some abnormal condition come within three classes; (*A*) those that are found to be unfit for slaughter, (*B*) those affected with a localized condition, and (*C*) those with a condition which has not advanced to the point which renders the animal unfit but which might influence the disposition of its carcass on post-mortem examination.

*A*. Animals found to be unfit for slaughter for food purposes are of two kinds. (1) Those which have reached that condition where treatment is impracticable, in which case they are condemned without sending them to the slaughtering department. They are then disposed of under the supervision of the inspector. (2) Those animals which are found to be affected by some condition which might respond to treatment. Generally, no facilities are provided on the premises of meat packing plants for the segregation and treatment of sick animals. In fact, an attempt to maintain such facilities on the premises may constitute a nuisance and interfere with the maintenance of good sanitary conditions. The treatment of sick animals, therefore, is accomplished somewhere outside of the premises and they are returned to the slaughtering plant only after a complete recovery has been made.

*B*. Animals affected with local conditions, such as fractures, abscesses, bruises, and the like, are segregated for further examination. This examination is for the purpose of determining the extent of the condition and to ascertain whether there is systemic involvement. The temperature of the

animal is taken, its respiration is noted, and the condition of exposed mucous membranes is observed. The results of this examination are recorded so that they are available when the post-mortem examination of the animal is conducted. The identity of each animal is maintained and it is slaughtered separately from the regular kill so that a more thorough post-mortem examination can be made. These animals are commonly referred to as "suspects." This term is used since the animal, because of the local involvement, is suspected of having a condition which might influence the disposition of its carcass or a part thereof on post-mortem examination. Figure 87 illustrates a metal tag used under Federal meat inspection. It is affixed to the animal's ear as identification. The post-mortem findings are interpreted in the light of the condition found on ante-mortem inspection and disposition of the carcass and its parts is made accordingly.

*C. The third group includes animals affected by a condition* which has not advanced to the point that would render the animal unfit. Such animals are also designated as "suspects." These animals are also segregated from the animals passed for slaughter on ante-mortem inspection and examined individually before being released for slaughter. The ante-mortem findings concerning their general appearance, temperature, respiration, and appearance of mucous membranes are also recorded so that they may be available when the post-mortem examination is conducted. These animals are also slaughtered apart from the regular kill and a thorough post-mortem examination is conducted on each animal. The ante-mortem condition is considered in connection with the post-mortem findings in finally disposing of a carcass or its parts.

**Cattle.**—The inspector conducts his ante-mortem examinations by first entering the pen quietly so that he may observe the animals while they are at rest. He notices their general conduct to determine whether they are fatigued, or whether they are resting quietly. Should the animals give the appearance of fatigue, he looks for cases of so-called shipping sickness. He notes the general appearance of each animal, particularly the respiration, which, if quickened, is an indication of some abnormal condition. All abnormal animals found at this stage are segregated immediately and taken to a holding pen equipped with a chute where they are examined individually. The next step is to observe the animals in motion. This means getting them all to their feet and watching them move about. Both sides of the animal are observed so that conditions, such as epithelioma of the eye, "lumpy jaw", and unhealed vaccination, will be detected. Animals so affected, as well as animals which move about stiffly, or are lame, are also removed to the holding pen and examined individually. Milk cows are observed for indications of mastitis. Signs of retained placenta are looked for. The inspector is alert to detect symptoms of such conditions as rabies, anthrax, listerellosis, and tetanus.

**Calves.**—The ante-mortem examination given calves is similar to that given cattle. The principal difference is the attention necessary to be given young calves to determine whether they have reached that maturity which would permit their being handled as food animals. Young calves which are too weak to stand up or to move about normally, or that lack normal

muscular coordination, are unfit for slaughter. Calves with infected navels with or without joint enlargement are segregated for individual examination to ascertain whether the condition is general or localized. Calves showing systemic involvement connected with navel infection are not permitted to be slaughtered for food purposes. Where the condition appears to be localized, the calf is handled as a suspect.

**Swine.**—Swine also are observed both at rest and in motion. The respiratory picture of a pen of swine at rest is important as it has a bearing on the general condition of a lot of swine. Care is exercised to distinguish between quickened respiration as a result of recent driving and the condition as it might be an indication of respiratory involvement. In those cases where a lot of swine appears to be affected generally with some respiratory condition, the lot is handled as a unit and examinations are made to determine whether the condition is due to hog cholera or similar affliction. None of a lot of hogs affected with hog cholera is taken to the slaughtering department. The entire lot is removed for treatment and not slaughtered for food until the hogs have recovered from the condition. Where the lot of swine presents no general disease condition, those animals which show any abnormal condition are removed to the holding pen and examined individually. The usual separation into unfit animals and those which are permitted to be slaughtered as suspects is made. Stags and boars are separated from the regular kill and identified for examination for sexual odor on post-mortem examination.

**Sheep.**—Sheep also are examined both at rest and in motion. Frequently during the warm months of the year individual sheep do not stand up well under shipping conditions. Sheep which are found to be weak are segregated and taken to the holding pen where they can be examined individually. These sheep are then separated into those which are unfit for slaughter and condemned and those which are permitted to be slaughtered as suspects. Sometimes several cases of tetanus will be observed in a lot of recently castrated lambs.

**Pathology.**—Disease conditions commonly encountered in making ante-mortem inspections are mentioned here. Only a very brief discussion of the pathology of each condition is given since the veterinarian and veterinary student are presumed to be fully informed concerning the pathology of diseases of animals through other courses of study. The discussion in each case is intended to point up the significance of the disease as it relates to the handling of animals during ante-mortem inspection and to their suitability for slaughter for food purposes.

**Listerellosis.**—This disease is most prevalent in the late winter and early spring, however, it does occur at other times of the year. It affects cattle and sheep principally. Man is also susceptible. It is usually manifested as a disorder of the central nervous system. In ruminants, the disease does not ordinarily sweep through a herd but may affect 10 per cent or less of the animals over a period of several months. Sheep appear to be more susceptible than cattle. The course of the disease runs more rapidly in sheep, and they seldom live more than from forty-eight to seventy-two hours In cattle, the disease runs for a week or more.

*Etiology and Pathogenesis.—Listerella monocytogenes* is the causative organism. In natural cases of listerella encephalitis in ruminants the organism has been isolated only from the central nervous system.

Number of Animals Condemned for Various Diseases and Conditions on Antemortem Inspection Fiscal Year 1956 under Federal Meat Inspection

| *Cause of Condemnation* | *Cattle* | *Calves* | *Sheep and Lambs* | *Swine* | *Horses* |
|---|---|---|---|---|---|
| Degenerative and dropsical conditions: | | | | | |
| Anasarca | 8 | | | | |
| Emaciation | 14 | | | | |
| Hydropic degeneration | 6 | | | 9 | |
| Miscellaneous | 4 | | | 4 | |
| Infectious diseases: | | | | | |
| Actinobacillosis and actinomycosis | 7 | | | | |
| Blackleg | 1 | 1 | | | |
| Swine erysipelas | | | | 5 | |
| Hog cholera | | | | 77 | |
| Necrobacillosis and necrosis | | | | 1 | |
| Miscellaneous | 4 | 1 | 1 | 45 | |
| Inflammatory diseases: | | | | | |
| Enteritis, gastritis, peritonitis | 3 | 2 | 1 | 1 | |
| Mastitis | 11 | | 2 | | |
| Metritis | 10 | | | 1 | 1 |
| Pericarditis | 8 | | | | |
| Pleurisy and Pneumonia | 20 | 14 | 4 | 8 | 1 |
| Miscellaneous | 3 | 1 | | 2 | |
| Neoplasms: | | | | | |
| Carcinoma | 3 | | | | |
| Epithelioma | 1,165 | | 1 | | |
| Miscellaneous | 2 | | | | |
| Septic conditions: | | | | | |
| Abscess or pyemia | | | | 38 | |
| Septicemia | 12 | 3 | 1 | 5 | |
| Toxemia | 1 | | 1 | | |
| Miscellaneous | 1 | 1 | | | |
| Arthritis | 2 | 7 | | 124 | |
| Hyperkeratosis | 2 | | | | |
| Immaturity | | 35 | | | |
| Injuries | 5 | | 1 | | |
| Moribund | 948 | 730 | 411 | 481 | 3 |
| Pregnancy advanced or recent parturition: | 6 | | 1 | | |
| Sexual odor | | | | 2 | |
| Skin conditions | 1 | | | | |
| Suspect died in pens | 324 | 83 | 104 | 349 | |
| Pyrexia | 80 | 26 | 77 | 427 | |
| Tetanus | 3 | 1 | | 12 | |
| Uremia | 2 | | | | |
| Miscellaneous general | 5 | | | 30 | 1 |
| Total | 2,661 | 906 | 605 | 1,621 | 6 |

Fig. 2

*Symptoms.*—A few animals may become violent at the onset of the disease and present a picture similar to rabies. Generally, the infected animal separates itself from the rest of the herd, becoming very depressed and refusing to eat. It will stand against a fence or building as though it needs support. When it walks, it usually travels in circles. The head is sometimes held to one side and facial paralysis sometimes occurs. The

temperature may be normal or elevated. Usually there is nasal discharge, and salivation occurs.

*Ante-Mortem Significance.*—Animals showing symptoms of listerellosis are unfit for slaughter for food. Should the condition be such as to justify treatment, the animal is removed to premises where proper treatment can be undertaken. Animals which have recovered from this disease are passed for slaughter as suspects.

**Anthrax.**—This disease is rather widespread throughout the United States. Large areas of infection exist in South Dakota, Nebraska, Mississippi, Louisiana, Texas, and California. There are anthrax areas also in Vermont, New Jersey, Delaware, Wisconsin, Utah, Nevada, and Oregon. This disease affects all species of animals as well as man. Sheep and cattle are particularly susceptible, with a high mortality. Hogs are less susceptible; there being a tendency for the infection to localize in the tissues in the region of the throat and neck.

*Etiology and Pathogenesis.*—The spore-bearing *Bacillus anthracis* is the causative organism. Infection of cattle and sheep takes place through the alimentary mucosa or may result from bites of contaminated insects. In these animals, the disease usually appears as an acute rapidly fatal febrile condition with a terminal bacteriemia. The organism also enters through the mucous membrane of swine but the infection tends to become localized in the adjacent lymph glands.

*Symptoms.*—Cattle and sheep are usually seen in the advanced stages of the disease. The animal trembles, staggers, and breathes with difficulty. Frequently there are discharges of bloody feces, urine, and saliva. Spasms occur in the final stages of the disease. Generally, anthrax in hogs is localized in the pharyngeal and parotid regions. Swelling of the neck may occur. This is difficult to detect on ante-mortem inspection unless the condition has progressed to the point where there is interference with respiration and swallowing. As the condition progresses toward asphyxiation, the mucous membranes become cyanotic.

*Ante-Mortem Significance.*—Animals showing symptoms of anthrax are unfit for slaughter for food. Such animals are removed immediately from the premises since they are a dangerous source of infection. The pens and runways in which the affected animals were handled are immediately cleaned of all straw, litter, and manure which are burned. The premises which have been exposed to the infection are then disinfected by soaking the floor, fences, gates, and all exposed material with a 5 per cent solution of sodium hydroxide or commercial lye. The sodium hydroxide or commercial lye should contain at least 94 per cent of sodium hydroxide. The solution is prepared immediately before being used by dissolving 2¼ pounds of sodium hydroxide or lye in 5½ gallons of hot water. To be most effective, this solution is applied as near scalding hot as possible. This sodium hydroxide solution is extremely caustic. The operator uses rubber gloves and boots to protect his hands and feet, and goggles to protect his eyes while performing the disinfection. A weak acid solution, such as vinegar, is held in readiness should any of the sodium hydroxide solution come in contact with the operator.

Animals which have been given prophylactic inoculations with anthrax

biologics that contain live anthrax organisms are not slaughtered for food purposes within six weeks of the inoculation, and then only if there is no evidence of disease and there is no evidence of a reaction to the treatment. Those animals which show inflammation, tumefaction, or edema at the site of the inoculation are considered unfit for slaughter until the reaction disappears.

This decision is based not only on a consideration of the condition of the animal but, of prime importance, avoidance of contamination with live anthrax organisms of the premises in which human food is prepared.

**White Scours of Calves.**—This is an acute, infectious disease affecting very young animals. It is characterized by diarrhea and rapid exhaustion, and it occurs generally in the spring and fall months.

*Etiology and Pathogenesis.*—The condition is most commonly caused by the *Bacillus coli communis* but it may be caused by any one of several virulent varieties of colon bacilli. The organism attacks the entire digestive tract, producing hemorrhagic inflammation of the abomasum, and to a lesser extent inflammatory changes in the intestines.

*Symptoms.*—The first symptoms appear within the first few days after birth of the animal. The affected animal becomes depressed and lies down much of the time. Diarrhea appears within a day or two of the infection. It is first yellowish, turning to grayish-white, sometimes foamy and blood-streaked.

*Ante-Mortem Significance.*—Calves in which the white scours has not progressed to a condition affecting the general well-being of the animal are passed for slaughter as suspects. Where the calf has become so weakened by the condition that it has insufficient strength to walk into the slaughtering department, it is unfit for slaughter for food.

**Rabies.**—Occasionally, rabies is encountered when ante-mortem examinations are made of cattle. All mammalian animals and man and many birds are susceptible to the disease.

*Etiology and Pathogenesis.*—The condition is caused by a filterable virus. The virus is found in the central nervous system of diseased animals as well as in the salivary glands and in the saliva. Infection occurs usually through the bite of a rabid animal, the virus entering the puncture wounds caused by the bite.

*Symptoms.*—Affected animals may show unrest, nervous irritability, and an uncommon aggressive behavior. Spasmodic convulsions may appear. The terminal symptom is progressive paralysis followed by death of the animal. In some cases the stage of irritability may be absent or of brief duration.

*Ante-Mortem Significance.*—Rabid animals are unfit for slaughter for food.

**Scrapie.**—This is a chronic, infectious, nervous disease of sheep and possibly goats which was first identified in the United States in April 1947. The disease is usually fatal and no effective treatment or vaccine has been found. The only known way of combatting the disease is to dispose of the flock and later to replace it with disease-free animals. Diagnosis of the disease is quite difficult. It may be confused with listerellosis.

*Etiology and Pathogenesis.*—Scrapie is believed to be caused by a filterable virus. The most trustworthy evidence of scrapie is the presence of vacuoles in the nerve cells of the brain and spinal cord. The disease is not transmissible to man.

*Symptoms.*—The animal may be nervous, apprehensive and excitable with slight tremors of the head and neck. It may drink increased amounts of water and maintain a good appetite. The temperature remains normal. Intense itching and rubbing is a characteristic symptom as the disease develops, hence the name, for the animal literally scrapes off its wool and even part of its skin. In spite of good appetite, the animal becomes weak and emaciated. Excitement may cause convulsions and coma. The gait becomes increasingly unsteady, the animal finally goes down and cannot get up and death ensues.

*Ante-mortem Significance.*—Animnls affected with scrapie are unfit for slaughter for food.

**Tetanus.**—This is an acute, infectious disease occurring sporadically and affecting all animals. However, it is not common to see this condition in cattle and swine on ante-mortem inspection.

*Etiology and Pathogenesis.*—*Clostridium tetani* is the cause of this disease. Its spores enter the body through soil contamination of wounds. The organism proliferates in contused muscle tissue and blood extravasations. The toxins formed by growth of tbe organism attack the nervous system.

*Symptoms.*—The condition is characterized by tonic spasms of the muscles with no resulting impairment of consciousness. The animal becomes stiff and finally is unable to move.

*Ante-Mortem Significance.*—Animals affected with tetanus are unfit for slaughter for food. Conditions are generally unfavorable for treatment. The better course is to destroy the animal.

**Blackleg.**—This is an acute infectious condition affecting cattle principally and sometimes sheep and goats. It appears chiefly during the warm months.

*Etiology and Pathogenesis.*—This condition is caused by the blackleg bacillus *Clostridium feseri.* The organism may enter the body through breaks in the skin or from the digestive tract. It localizes and develops, however, at a point where some destruction of tissue or extravnsation of blood exists. The growth of the organism results in n local lesion characterized by gas formation nnd a toxic systemic involvement accompanied with high tempernture symptoms. The nffected nnimal is depressed and has a high temperature. The presence of n crepitnnt swelling in the musculature of a part of the body chnracterizes this disease.

*Ante-Mortem Significance.*—Animnls affected with blackleg are unfit for slaughter for food. They nre removed for treatment or if treatment is impracticable, they nre destroyed for food purposes.

**Swine Erysipelas.**—This is an infectious disease of hogs. Three forms are recognized: the ncute (septicemic), the urticarial (diamond skin disease), nnd chronic (arthritic). It has become rather prevalent throughout the midwestern States. The disease is more prevalent during the spring nnd summer, occurring only occasionally during the cold months. Man is also susceptible to the organism which produces this disense. In man,

the condition usually occurs as a local skin infection causing painful red, elevated lesions.

*Etiology and Pathogenesis.*—The organism *Erysipelothrix rhusiopathiæ* is the causative agent. The infection usually occurs through the digestive tract, taking on the form of a septicemia. Indications are that the organism is not found in the blood stream as the animal recovers from the condition or the condition becomes localized.

*Symptoms.*—In the septicemic form of the disease, the animal is dull and depressed with a high fever. A characteristic redness usually appears in spots on the abdomen, the axillary region, and the inner surface of the thighs. Urticaria characterizes a more benign form of the disease. Chronic erysipelas occurs chiefly in the form of an arthritis.

*Ante-Mortem Significance.*—Animals plainly affected with the septicemic form of swine erysipelas are unfit for slaughter for food. Those suspected of being affected with swine erysipelas or with a localized condition of that disease are handled as suspects.

**Vesicular Exanthema.**—This condition affects swine and has been seen in the United States only in the western coastal area. It is distinguished from foot-and-mouth disease since it is not transmissible to cattle. It is an infectious, contagious condition but it does not spread so extensively as foot-and-mouth disease.

*Etiology and Pathogenesis.*—The condition is caused by a filterable virus. The liquid expelled from the vesicles which form on the mouth, tongue, and feet is very infectious.

*Symptoms.*—Large vesicles form in the epithelial covering of the lips, snout, tongue, and in the skin of the feet between the claws or around the coronary band. Udder and teat lesions may be found on nursing sows. The animals run a high temperature during the formation of the vesicles which subsides as the vesicles break and the resulting ulcers progressively heal.

*Ante-Mortem Significance.*—Animals affected with vesicular exanthema accompanied by acute or active lesions or an elevated temperature are unfit for slaughter for food. If treatment of these animals is practical they are removed from the premises for the purpose. Otherwise they are destroyed for food purposes. Animals which have recovered to the extent that the lesions are healing and the temperature range is normal are handled as suspects.

**Vesicular Stomatitis.**—This disease affects horses principally, although natural infection sometimes occurs in cattle and rarely in swine. This distinguishes it from foot-and-mouth disease. Sheep have been infected experimentally. Vesicular stomatitis of cattle is very rarely encountered in making ante-mortem inspection.

*Etiology and Pathogenesis.*—A filterable virus is the causative agent of this condition. The infection is believed to gain entrance through abrasions or injuries of the mouth and is picked up from contact with infected animals or from infected feed or troughs.

*Symptoms.*—Vesicles form on the tongue and in the mucous membrane of the lips and cheeks. This is accompanied with high fever and salivation. Generally, vesicles do not appear on the udder or feet. As the temperature

returns to normal and the vesicles rupture, the sore surfaces heal readily unless they become affected with a secondary infection.

*Ante-Mortem Significance.*—Cattle affected with vesicular stomatitis in the acute stages are unfit for slaughter for food. Animals recovering from the condition, with normal temperature and with lesions in the process of healing, are handled as suspects.

**Parturient Paresis.**—This is a condition of paralysis and loss of consciousness occurring usually at the termination of parturition. It develops much more commonly in cattle than in other species of animals.

*Etiology and Pathogenesis.*—The cause of the condition is unknown. Certain predisposing factors have been identified with the condition. It is a generally accepted theory that attacks are precipitated by an acute fall in the blood calcium concentration, but the responsible factors have not been definitely determined. The condition usually affects cows that are especially good milkers and occurs more frequently during the fifth to tenth years of life.

*Symptoms.*—There is no fever. The attack usually occurs one to three days after parturition. The characteristic paralysis and depressed consciousness are occasionally preceded by a brief period of excitement.

*Ante-Mortem Significance.*—An animal affected with this condition is unfit for slaughter for food. Should conditions warrant, the animal is removed to a location where treatment can be undertaken. Should recovery be effected, the animal is handled as a suspect.

**Railroad Sickness.**—This condition, which is similar to parturient paresis in many respects, affects cows which are usually in the advanced stages of pregnancy and occurs during or after a long continued transportation by rail.

*Etiology and Pathogenesis.*—The cause of this condition is also unknown. Since it occurs invariably in the animal being shipped for long distances in a standing position in a crowded, hot railway car, such handling of the animal may be regarded as responsible for the onset of the attack.

*Symptoms.*—The condition develops progressively from an attitude of unrest to an uncoordinated condition associated with a staggering gait. Consciousness is gradually lost. The animal presents a picture very much like parturient paresis.

*Ante-Mortem Significance.*—Animals affected with railroad sickness are unfit for slaughter for food. Where practical, they are removed for treatment which, if undertaken promptly, is usually successful. Animals that have recovered from this condition are handled as suspects.

**Epithelioma of the Eye.**—This condition is most commonly encountered in cattle and consists of a carcinomatous involvement of the orbital region.

*Etiology and Pathogenesis.*—The cause is not definitely known. Lack of pigment in the ocular mucosa of certain breeds of cattle and irritation by sand and other irritants are believed to be predisposing factors. The carcinoma begins in the mucosa of the lower lid or in the membrana nictitans from which it extends into the entire orbit, surrounding bone, and adjacent region.

*Symptoms.*—There are considerable swelling and inflammatory changes as the condition develops. Areas of necrosis form and there is considerable

discharge from the lesion. Metastasis to the parotid region frequently occurs.

*Ante-Mortem Significance.*—Animals affected with this condition are considered unfit for slaughter for food when the eye has been destroyed or obscured by neoplastic tissue showing extensive infection, suppuration, and necrosis, or if the condition is accompanied with cachexia. Animals affected with this condition to a lesser extent are handled as suspects.

**Actinomycosis and Actinobacillosis.**—These conditions are considered together because they present a very similar ante-mortem picture even though they are produced by two different organisms. These conditions are seen in cattle. They are both transmissible to man.

*Etiology and Pathogenesis.*—Actinomycosis is caused by the "ray fungus", *Actinomyces bovis*. Actinobacillosis is caused by the organism *Actinobacillus lignieresi*. Actinomycosis usually affects the bony structures of the head, especially the mandible, whereas actinobacillosis usually affects the soft tissues in this area, such as the tongue and lymph glands.

*Symptoms.*—The conditions are characterized by enlargements occurring in the cervical region in the form of large abscesses which may or may not be discharging pus when seen on ante-mortem inspection. When the condition affects the bone there is also considerable enlargement of the area with or without discharge.

*Ante-Mortem Significance.*—Animals affected with these conditions are handled as suspects unless the condition is accompanied with cachexia, in which case the animal is unfit for slaughter for food.

**Shipping Fever.**—This condition is sometimes called hemorrhagic septicemia and affects both cattle and sheep. It is commonly associated with the hardships experienced by livestock during shipping, and inclement weather appears to be a predisposing factor.

*Etiology and Pathogenesis.*—The hemorrhagic septicemia organism probably plays a secondary role; the nature of the primary infective agent is not known but is thought by some to be a virus. Shipping fever in many respects resembles influenza-type virus diseases.

*Symptoms.*—The onset of the condition is rapid. Affected animals show an elevation of body temperature ranging from 104° to 107° F. The condition is characterized by general depression of the animal and distressed breathing accompanied with a hacking cough, swollen, watery eyes, and a mucopurulent discharge from the nose. Swelling may appear beneath the skin of the head, throat, or dewlap. The tongue is often extensively swollen and, because of the irritation of its tongue and throat, the animal drools and slobbers. Shivering and muscular trembling may be evident. Small hemorrhages may be seen in the mucous membrane of the nostrils. The condition sometimes develops into pneumonia.

*Ante-Mortem Significance.*—An animal in the acute stages of this condition is unfit for slaughter for food. It may be removed to a location where treatment can be undertaken. An animal which has sufficiently recovered is handled as a suspect.

**Selenium Poisoning.**—This condition is sometimes called "alkali disease" and affects livestock which eat selenium-contaminated feed. The principal areas of seleniferous soils which produce plants of excessive selenium

content are in South Dakota, Montana, Wyoming, Nebraska, and Kansas. Other States in the Great Plains and Rocky Mountains contain a few of these areas.

*Etiology and Pathogenesis.*—The excessive amount of selenium in grain or forage grown on seleniferous soils is the cause of the so-called "alkali disease." The condition is manifested principally by its effect on the hair and horn producing tissue. Removal of animals from selenium-contaminated feed is corrective of the condition.

*Symptoms.*—There is an alteration in the growth of horns and hoofs, and a loss of hair from the switch of cattle and from the back of swine. Affected swine show a general scarcity of hair but this is most marked along the back, the shoulders, and the hips. The tissue in the region of the coronary band from which the hoof develops becomes swollen and in some cases appears to have lost its ability to produce horny tissue.

*Ante-Mortem Significance.*—Where the animal is so affected as to indicate that it had not been removed from the selenium-contaminated feed for sufficient time to bring about a correction of the condition, it is unfit for slaughter for food. If, however, the animal appears to be in good health and shows a tendency toward the return of its hair coat and new horny tissue is evident above the abnormal hoof condition, it is passed for slaughter but handled as a suspect.

**Fluorine Poisoning (Fluorosis).**—Fluorine is a cumulative poison. It is widely distributed in nature in soil, rocks, water, and plants. Concentrations of fluorine in the soil sufficient to contaminate grain and plants grown thereon have been reported in parts of Arkansas, California, South Carolina, and Western Texas. The principal source of trouble with fluorine poisoning has been in connection with feeding mineral mixtures containing natural phosphatic limestone or rock phosphates which are usually high in fluorine. Poisoning of livestock has also occurred from eating vegetation contaminated with fluorides in the vicinity of aluminum manufacturing plants.

*Etiology and Pathogenesis.*—Fluorine has a marked affinity for calcium and its toxic effect in the animal body is probably due to its interference with normal calcium metabolism. A high calcium diet apparently tends to lessen the retention of fluorine. Fluorine poisoning is characterized by bone atrophy, abnormally structured osseous tissue, and irritation of the gastrointestinal tract.

*Symptoms.*—Generally, the symptoms consist of abnormal teeth and bones, stiffness of joints, loss of appetite, and emaciation as the condition progresses.

*Ante-Mortem Significance.*—An animal affected with fluorine poisoning is unfit for slaughter for food. It may be removed for treatment which would contemplate placing it on feed not contaminated with fluorine. Such treatment permits gradual elimination of fluorine concentration in the animal; however, the bone and teeth developments are not reversible. An animal which responds to treatment is passed for slaughter but handled as a suspect.

**Hyperkeratosis.**—This condition is sometimes referred to as "X" disease of cattle. It was first reported in the United States in 1939 in New York State. It has been reported as occurring only in cattle.

*Etiology and pathogenesis.*—Hyperkeratosis has been found to be caused by the injection of substances containing chlorinated naphthalenes of which penta-, hexa-, and heptachlorinated naphthalenes are the most toxic. These chemicals occur in lubricants, wood preservatives, and cresylic type disinfectants. They have also been identified in toxic pelleted feeds and milk from affected cows. The condition is characterized by hyperkeratosis involving the skin, muzzle, and inside of the mouth. The areas of skin most commonly affected are those between the hind legs, behind the ears, and sides of the neck and shoulder extending over the sides of the animal.

*Symptoms.*—The skin becomes hard, thick, and wrinkled, sometimes developing wart-like protuberances or proliferations. Such proliferations also sometimes occur on the muzzle, inside the cheeks, and on the tongue, palate, and gums. Ulceration of the mouth and skin may occur due to secondary infections.

*Ante-Mortem Significance.*—When the condition has progressed to the point where the animal shows systemic involvement, cachexia, or emaciation, it is unfit for slaughter for food. If the condition appears to be localized, the animal may be passed for slaughter but handled as a suspect.

**Poultry.—General.**—Live poultry is usually received at the slaughtering plant in coops, baskets, and batteries loaded on trucks. Frequently the poultry is hung directly onto the slaughtering line from these trucks. There are usually facilities in the slaughtering plant for holding poultry prior to slaughter in which case the poultry is transferred from trucks to batteries in the holding area. Slaughtering pens are used for holding certain classes of poultry, usually ducks, geese, and, on occasion, turkeys. These pens usually accommodate a large number of birds which are hung on the slaughtering line directly from the pen. The inspector has an opportunity to observe the birds between the time they arrive at the slaughtering plant and when they are hung on the slaughtering line. In slaughtering off trucks, the inspector observes the birds at rest in a line of coops or baskets prior to start of removal of birds for transfer to the slaughtering line. In plants where poultry is held in batteries in a live poultry area or room awaiting slaughter, the inspector observes the birds at rest in the batteries. In such case, the batteries are so arranged as to afford an adequate space for the inspector to move freely between the rows to conduct his inspections.

In all cases, adequate lighting is provided so that the inspector can observe the individual birds in whatever manner they are held. Overloading is avoided in coops, batteries, and compartments which contain that number of birds consistent with good commercial practice, humane methods of transportation and handling, and opportunity for the conduct of ante-mortem inspection.

Individual birds are handled as observation of clinical symptoms and appearance of the bird warrant. The inspector handles the birds from time to time to assure himself concerning the body temperature, the fleshing, and state of dehydration.

Like animals, birds are found to be affected with abnormal conditions that come within three classes, (*A*) those that are found to be unfit for slaughter (*B*) those affected with a localized condition, and (*C*) those

affected with a condition which has not advanced to the point which makes the bird unfit for slaughter but which might influence the disposition of its carcass on post-mortem examination.

*A*. There are two classes of birds that are found on ante-mortem inspection to be unfit for slaughter for food purposes. (1) Those in a moribund condition from disease or other cause such as heatstroke or injury resulting from trauma. These include birds that have reached a condition where treatment is impracticable. In these cases the birds are condemned without sending them to the slaughtering department. They are destroyed and denatured under the supervision of the inspector or otherwise handled under his supervision in a way that will assure their elimination from the food supply. (2) Sometimes birds that are regarded as being unfit for slaughter for human food may be affected by a condition that might respond to treatment. Such treatment is undertaken off the premises of the slaughtering establishment and is under the supervision of an official having poultry disease control responsibilities.

*B*. Injured birds that are otherwise strong and in good health may be handled as "suspects" and taken into the slaughtering department for post-mortem examination to determine their fitness for human food. These birds are handled according to the routine described for "suspects," referring to animals on page 34.

*C*. This group includes birds affected by a condition to the point which would not render them unfit for slaughter. These birds include those which have some clinical symptom or condition which warrants their being retained as "suspects" but not condemned on ante-mortem inspection. They are handled as "suspects" taken to the slaughtering department where they are given a special post-mortem examination. The ante-mortem findings are considered along with the post-mortem findings in determining whether the carcasses from such birds can be regarded as being fit for human food.

**Diseases Transmissible to Man.**—The transmissibility of ornithosis to man has created some special problems in the poultry industry. Workers employed in poultry packing plants, especially those handling the live birds and those working at the slaughtering, plucking, and eviscerating positions in the dressing operation, have on occasion contracted the disease from affected birds in varying degrees of severity. In fact, there have been cases of severe illness and death following the contraction of the disease by these workers. There is no record of eviscerated carcasses transmitting the disease.

Public health officials, therefore, as well as poultry disease control officials, have a real interest in occurrences of ornithosis in poultry. Close liaison has been developed between these officials and poultry inspection programs, and arrangements have been worked out whereby veterinary poultry inspectors report occurrences of ornithosis and other poultry diseases that are transmissible to man whenever such conditions are detected by them in the poultry packing plant. The following which is quoted from an order issued by the Federal Poultry Inspection Service to its field organization is an example of such an arrangement: "The inspector in charge should, in cases which have aroused suspicion of ornithosis or any other disease directly transmissible to man, make every effort to learn the

flock history through the official plant management personnel, pick-up crews, trucker, and so forth, and advise the plant management of the suspicion. Inquiry should be made through the plant management personnel as much as possible and through them see that appropriate local public health officials, state veterinarians, and livestock sanitary officials are informed. Those persons will have the opportunity to investigate properly the suspicions and working with them the inspector in charge will see that blood and tissue specimens are collected for transmittal to the appropriate laboratories. The flock owner shall be advised at once of the suspicion of ornithosis or other disease condition transmissible to man, and the slaughter of the balance of the suspect flock deferred pending further checking of flock history and action by state and local officials. They may wish to quarantine the flock and supervise a treatment procedure before release and slaughter of the flock in line with what is permissible, following as laboratory diagnosis and proper indications of flock health conditions. If no clinically ill birds have been observed but the post-mortem inspector has noticed suspicous lesions, he should make or have inquiry made of the ante-mortem inspector prompting closer observation and proceed as just outlined when the ante-mortem inspector was the one to observe suspicious clinical symptoms."

**Pathology.**—Usually, when conducting his ante-mortem inspection of birds, the inspector has no history or knowledge of the flock to aid him in making a diagnosis of his findings. The veterinarian's decision as to whether a bird is fit for slaughter for human food is based on an appraisal of the symptoms and lesions of the individual bird and of the flock. He may also have some information on the current poultry disease conditions in the area where the birds originated.

**Respiratory Disease Complex.**—The respiratory diseases of birds are of great importance in ante-mortem inspection of poultry for two reasons. First, the respiratory system of birds is so constructed and arranged that a sudden, forceful expiratory effort cannot expel accumulating discharges from the air passages. This is due to the lack of a muscular diaphragm in birds and the ramification of the bronchi to the air sacs and hollow bones. Respiratory diseases, therefore, are not usually confined to the upper air passages or even the lungs as is the case in mammals. This anatomical arrangement allows the widespread contamination of the respiratory system with disease organisms and exudates.

Secondly, the respiratory diseases of birds are widespread, economically very important, and commonly, there are multiple infections of different agents complicating the disease picture. There are various viral agents, pleuropneumonia-like organisms, and bacteria which contribute to the respiratory disease complex.

The more important respiratory diseases are discussed here as the diseases appear when uncomplicated. However, there is some doubt that chronic respiratory disease ever occurs in the field without being complicated with a variety of causative agents.

The identification of a specific respiratory disease on ante-mortem inspection is made difficult by the fact that the symptoms are difficult to distinguish and that diseases tend to occur simultaneously. The most common

respiratory diseases in birds in the United States are Newcastle disease, chronic respiratory disease, infectious bronchitis, with occasionally infectious laryngotracheitis and *hemophilus gallinarum* infection.

Although birds cannot cough as mammals do, they try to expel accumulations of discharges from the air passages by a rapid snapping of the head and neck with a sideward flip of the beak. This effort is commonly referred to as coughing in birds and in this chapter the word coughing is so used.

**Infectious Laryngotracheitis.**—This has lost much of its economic importance since a successful vaccination procedure was developed in 1932. In areas where it is endemic, regular vaccination controls it satisfactorily. Only occasionally is it encountered on ante-mortem inspection. When it does occur it is an important disease of market-age birds. The disease usually spreads rapidly in a flock and all or most of the birds become affected. It may be confused with infectious bronchitis and Newcastle disease.

*Etiology and Pathogenesis.*—The causative agent is a filterable virus. The virus has a distinct host and tissue specificity. These being the mucous membranes of the larynx and trachea of chickens. The natural infection involves the respiratory mucous membranes.

*Symptoms.*—The outstanding symptoms are gasping, rales, and coughing. Birds are depressed. Some exhibit gasping with the head extended and the beak open. In severe cases, sneezing is frequent often resulting in expulsion of bloody mucous from the trachea. The head of the bird may be cyanotic. An accumulation of excessive amounts of inflammatory exudate and blood in the lumen of the larynx, trachea, or syrinx is characteristic. When cyanosis occurs, it is a result of asphyxiation. The birds do not run a temperature and were it possible for the birds to expel the exudate, the disease would cause little if any mortality.

*Ante-mortem Significance.*—Birds showing symptoms of infectious laryngotracheitis in an advanced stage with cyanosis are unfit for slaughter for food. Birds that have recovered from the disease or show only initial symptoms are passed for slaughter as suspects.

**Infectious Bronchitis.**—This is an acute respiratory disease of chickens and is highly contagious. The disease may occur in all age groups though the mortality is confined almost entirely to chickens of pre-market ages. The disease in adult stock is of great economic importance in laying birds where it causes a precipitous drop in egg production of several weeks duration. Generally, in market-age birds, symptoms are of a minor nature.

*Etilogy and Pathogenesis.*—A filterable virus is the causative agent of infectious bronchitis. Susceptible chickens can be readily infected by intranasal or intratracheal inoculations of tracheal exudate or lung tissue suspension from an infected chicken.

*Symptoms.*—Nasal discharge, gasping, rales, and coughing are characteristic symptoms. However, the nasal discharge is usually not observed in chickens over six weeks of age and in adult birds. The course of the disease is usually one or two weeks, although it is not uncommon for a few birds in a flock to have symptoms for longer periods.

*Ante-Mortem Significance.*—Birds affected with acute infectious bronchitis in advanced stages associated with debilitation are unfit for slaughter for

food. Should the condition be such as to justify treatment, the birds are removed to premises where proper treatment can be undertaken. Birds that have recovered from this disease are passed for slaughter as suspects, and this applies also to birds lightly affected.

**Newcastle Disease.**—This disease was first recognized in the Far East where it destroyed practically every bird in affected flocks with an acute systemic toxic action. The few birds which survived this stage usually showed central nervous system damage. In the 1920's and 1930's it spread to India, Africa, Europe and England with devastating results. During the late 1930's a disease of relatively mild character with respiratory and central nervous system symptoms appeared in California which was named pneumoencephalitis. It was not until 1944 that this disease was recognized as serologically identical to Newcastle disease. In 1945 it was found in the Eastern broiler areas, and since that time it has been the most important disease of birds in the United States. The disease is usually relatively mild, however, with some mortality under 20 per cent. Some outbreaks have shown the toxic characteristics common to the Asian type Newcastle disease.

*Etiology and Pathogenesis.*—A filterable virus is the infective agent of Newcastle disease. It is more highly resistant to adverse environmental conditions in nature than most viruses.

*Symptoms.*—The disease usually appears suddenly and spreads quickly. Generally the first sign is respiratory distress of varying severity, with coughing and gasping by a few or all of the birds. The symptoms are identical with those of infectious bronchitis and chronic respiratory disease, and closely resemble the symptoms of laryngotracheitis. Depression and impaired appetite are characteristic. In the more severe outbreaks, depression and prostration are frequent.

*Ante-Mortem Significance.*—Poultry affected with Newcastle disease in the acute stage are unfit for slaughter for food. Those which have recovered from the infection but which show residual nervous tissue destruction are also unfit for slaughter for human food.

**Chronic Respiratory Disease.**—This was first recognized as a separate disease entity in 1951 and the etiological agent was isolated in 1952. Chronic respiratory disease was first encountered following the widespread use of antibiotics in poultry feed and of Newcastle disease live virus vaccination. No definite conclusions are drawn concerning relationships in this connection and all comment has been speculative. This disease appears to be of equal importance to Newcastle disease as economic factors in the poultry industry.

*Etiology and Pathogenesis.*—A very small organism similar in size to that causing contagious pleuropneumonia in cattle is the infectious agent. It is referred to as PPLO meaning pleuropneumonia-like organism.

*Symptoms.*—Symptoms are similar to those encountered in the other diseases of the respiratory disease complex.

*Ante-Mortem Significance.*—Poultry affected with chronic respiratory disease in the acute stage are unfit for slaughter for human food. Those that are otherwise normal except for a slight respiratory distress may be passed as suspects.

**Coryza.**—*Hemophilus gallinarum* is the bacteria causing the disease that might be refferred to as common colds in birds. Usually a thin mucous and serous exudate characterizes the catarrhal inflammation which results from the infection. More severe infection may produce swelling of the head (edema not sinusitis) or respiratory distress as evidenced by gaping and coughing. Birds of all ages are affected and respond well to treatment with sulpha drug medication.

*Ante-Mortem Significanee.*—Birds showing acute stages of this condition affected with debilitation are unfit for slaughter for human food. Birds lightly affected may be passed as suspects.

**Ornithosis.**—This condition affects many species of birds causing enzootics among parrots, parakeets, cockatoos, and psittacine birds generally. The disease is an apparent but more frequently an inapparent infection. It affects chickens, turkeys, ducks, pheasants, pigeons, and other birds frequently taking the form of a latent inapparent infection. The disease also affects man and is characterized by rather sudden onset of chills and fever with unusually pronounced and persistent general aching. Severity of the infections is highly variable. Symptomless, mild, moderate, severe, and fatal infections have all been observed among groups showing serologic evidence of the infection.

*Etiology and Pathogenesis.*—The disease is caused by a large elementary body virus which passes, when multiplying, through a regular sequence of developmental forms. Elementary bodies of all sizes are visible in smears from infected pericardial or peritoneal exudates or organs of affected birds. In all infections the agent invades and destroys reticulo-endothelial cells.

*Symptoms.*—A flock of infected turkeys showed the following symptoms: the flock generally was droopy, anorexic and feverish. Many were weak and reluctant to move when disturbed. On being driven, some staggered and fell, manifesting acute respiratory distress and died within a few minutes. Some were extremely emaciated, their wattles were dry and cyanotic and their eyes dull and sullen. Many had eye lesions ranging from slight inflammation of the conjunctiva to complete necrotic obliteration of the orbit. The grounds of the pens were heavily blotched with soft or liquid yellowish droppings, some of which were blood-tinged. Soiling and matting of the vent feathers was common, the cloacae of many birds were everted. Some birds had lost a lot of feathers from the breast and back exposing large areas of skin. The sternums of many birds were ulcerated and abscessed and the wing tips were heavily contused and abraised by the efforts of the birds to rise to their feet.

*Ante-Mortem Significance.*—Birds affected by this disease are unfit for slaughter for food.

**Paralysis.—Neural Lymphomatosis.**—This is an entity in the avian leukosis complex. It is one of the group of diseases which is characterized by autonomous proliferation of the precursors of leukocytes. This is the true fowl paralysis. Paretic symptoms also may be observed as accompanying a variety of diseases such as tuberculosis, staphylococcosis, fowl cholera, helminthiasis, coccidiosis, botulism, avitaminosis, lead and salt poisoning, and the like.

*Etiology and Pathogenesis.*—The causative agent has not been identified.

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The transmissibility of neural lymphomatosis has been questioned frequently in literature. However, claims have been made for transmissibility by viable cells and even by cell-free material.

The disease is associated with the mononuclear leukocyte infiltration of the peripheral nerves.

*Symptoms.*—There is an asymmetric progressive paresis of the leg, wing, or neck, the paresis being either spastic or flaccid. If the disease attacks the leg there may appear inward curving of toes, weakness, or incoordination. Later, the foot may be stretched forward or backward in a position characteristic of the condition. When both legs are affected the bird moves with difficulty in a squatting position. The affected wing will droop at the extremity. The symptoms of true fowl paralysis are not specific and vary widely in intensity. Paresis of the neck is evidenced by low carriage of the head and incipient torticollis. Paralysis of the deeper muscles of the neck may lead to dilatation of the crop and gasping symptoms. Characteristic of the condition is the soiled, damp front feathers under the beak and along the throat resulting from slobbering. Locomotory disturbances are often associated with systemic reactions such as loss of weight, paleness, anorexia, and diarrhea. This may occur even though the appetite remains good.

*Ante-Mortem Significance.*—Birds affected with this disease are unfit for slaughter for food.

**Diarrheal or Enteric Diseases.—Coccidiosis.**—The coccidial infections of chickens have been of more economic importance than any other infection. However sanitary practices and bacteriostatic agents have controlled this infection to the point that clinical coccidiosis is seldom seen in market broilers.

*Etiology and Pathogenesis.*—Coccidiosis is a general term applied to infection with one or more of the many species belonging to the genus coccidia, a subdivision of the protozoan class sporozoa. Of the many known genera of the coccidia there are two of importance, namely, eimeria and isospora.

*Ante-mortem Significance.*—The more lightly affected birds are handled as suspects. Birds showing any significant degree of anemia are unfit for slaughter for food.

**Infectious Enterohepatitis (Black Head).**—This is a protozoan disease of turkeys and chickens dependent on carriers including not only chickens and turkeys, but other birds as well. The carriers eliminate the causal organism in the feces. When the organism is ingested by susceptible stock, infection results. This disease is credited with being the cause of temporary abandonment of the turkey industry in some sections of the eastern and midwestern United States.

*Etiology and Pathogenesis.*—The causative agent is the parasite, *Histomonas meleagridis*. It is classed as a flagellate but is one of the few that also has an amoeboid stage. It is harbored by the common poultry cecal worm, *heteralis gallinae*, found in the ceca or blind pouches of a large percentage of chickens The parasite can live for long periods in the cecal worm and its eggs. The liver and the ceca are the principal organs affected.

*Symptoms.*—A constant sulphur-colored diarrhea is a characteristic symptom. There is also drowsiness, weakness, drooping wings and tail, a

lowered head and ruffled feathers. The common name "Black head" used in connection with this condition is a misnomer.

*Ante-mortem Significance.*—Turkeys showing significant systemic involvement with infectious enterohepatitis are unfit for slaughter for food. Slightly involved birds and those that have recovered from the disease are handled as suspects.

**Acute Septicemic Diseases.**—There are a number of these and under conditions surrounding the conduct of ante-mortem inspection it is difficult to make specific diagnosis. A few of the more common diseases encountered of this class are mentioned here.

**Fowl Typhoid.**—This disease affects chickens primarily but also, in exceptional cases, it may affect ducks, turkeys, pheasants, and a few others. It is a septicemic disease and its course may be acute or chronic. Birds of all ages are affected from baby chicks to breeding hens and the disease occurs with equal frequency in young and mature stock. Gastroenteritis in man has been reported on occasions as caused by the organism identified with fowl typhoid.

*Etiology and Pathogenesis.*—*Salmonella gallarum* is the causative organism of fowl typhoid. There has been some difficulty in the classification of this organism due to its close relationship to *Salmonella pullorum*. Like most other bacterial diseases, fowl typhoid is spread in several ways. Investigation indicates that in infected birds the reactor and carrier is by far the most important means of perpetrating and spreading the disease. Such birds may infect not only their own generation, but succeeding generations through egg transmission.

*Symptoms.*—In acute cases the comb and wattles may be dark-colored. The birds become listless and inactive. A thin, greenish-yellow diarrhea appears early. There is complete loss of appetite and intense thirst is common presumably as a result of high fever. In acute outbreaks losses may be heavy and visibly sick fowl generally do not survive. Classical fowl typhoid is a chronic disease of older birds in which blood destruction is the principal effect. Anemia and greenish-yellow diarrhea are characteristic.

*Ante-mortem Significance.*—Birds affected with the septicemic form of fowl typhoid are unfit for slaughter for human food.

**Fowl Pox.**—This is a widespread disease that is prevalent wherever poultry is raised. The greatest incidence of infection is during the fall and winter months.

*Etiology and Pathogenesis.*—The causative agent of fowl pox is a filterable virus. There appear to be at least 4 different viruses or strains of virus causing pox among birds, namely, fowl, pigeon, canary, and turkey. Fowl pox virus, like other viruses, can be cultivated only in the presence of living cells of susceptible hosts.

*Symptoms.*—Fowl pox infection may be manifested in one of three forms or a combination of these forms depending on the virulence and pathogenicity of the strain of virus involved: (1) localization of typical cutaneous pox lesions on the comb, wattles, and face region; (2) localization of the infection in the mouth region with the appearance of typical diphtheritic lesions; and (3) localization of infection in the nasal chambers with accompanying coryza-like symptoms. Occasionally, pox lesions are observed on the feet, legs, and body of chickens reared on wire floors.

*Ante-mortem Significance.*—Birds systemically affected with fowl pox in the debilitating febrile stage are unfit for slaughter for human food.

**Fowl Cholera.**—This is a contagious disease usually systemic in nature and manifested by high morbidity and mortality. Fowl cholera is widely distributed in temperate and warm regions. It may occur enzootically or sporadically. Domestic fowls of every type are susceptible.

*Etiology and Pathogenesis.*—The causative agent of fowl cholera is the *Pasteurella multocida*, one of the hemorrhagic septicemia producing group. The infection is given off by diseased birds especially in the body wastes which contaminate the soil as well as the food and water.

*Symptoms.*—The disease may kill so rapidly that sick birds are not seen. In other cases, sick birds may be numerous, lingering for a few days. Such birds become stupid, refuse to eat or drink and rapidly emaciate. Many become lame because of localization of the organism in the joints of legs or wings. The wattles, too, may become the seat of infection, becoming edematous, hot, and painful. Difficult breathing indicates the presence of mucous in the respiratory passages. Diarrhea may or may not occur. In peracute cases it is unusual because the birds do not live long enough for it to develop. When there is diarrhea, the evacuations are copious, watery, and of a grey, yellow, or green color. The head frequently becomes cyanotic. The combs and wattles may become a dull, purple color.

*Ante-mortem Significance.*—Birds affected with the septicemic form of fowl cholera are unfit for slaughter for human food.

**Botulism.**—This condition, also called limberneck, affects not only chickens and other domestic birds, but also man and domestic animals. It is a type of food poisoning. Botulism can result from the consumption of carcasses of birds which have died of the disease and also of the maggots of the blue-bottle fly on spoiled meat. The maggots become extremely poisonous from ingesting the toxin impermeated meat.

*Etiology and Pathogenesis.*—The disease is caused by toxins which are the product of the growth of *Clostridium botulinum.* Some 15 sub-types of this species have been identified, but Type A and Type C are the most common causes of botulism in domestic birds. The toxin is one of the most powerful poisons known. It is sometimes referred to as a nerve poison.

*Symptoms.*—The most common symptom is paralysis which may appear within a few hours to a day or two after the spoiled food is eaten. First affected are the legs and wings, the birds becoming unable to walk and their wings drooping. When the neck muscles are affected, the head hangs limp, therefore the name "limberneck." Looseness of feathers is often seen in botulism. In mild cases there may be recovery in two or three days, however, fatally affected birds lie in a profound coma.

*Ante-mortem Significance.*—Birds affected with botulism are unfit for slaughter for food.

Chapter

# 4

## POST-MORTEM INSPECTION

THE inspection that is conducted in the slaughtering department is usually referred to as the post-mortem inspection. However, the examination of the carcass, its organs and other viscera which constitutes the post-mortem inspection is only part of the responsibilities of the inspector in the slaughtering department. Inspection procedures in that department are so organized as not only to provide a thorough post-mortem examination but also to eliminate contamination of meat during each step of the intricate slaughtering operations.

**Technique.**— **General.**—Diseased carcasses and parts are detected by the inspector and they are destroyed for food purposes under his supervision. The handling of diseased material incident to its disposal is so done as to avoid contamination by it of meat which is being prepared for food. Neither is the diseased material permitted to contaminate any equipment in which meat is handled or with which any meat may come in contact. Similarly, the separation of edible portions of the carcass from inedible portions is accomplished without contaminating the edible portions. For example, the gastrointestinal tract is removed from the carcass without any of the contents of that tract coming in contact with or in any way contaminating the carcass meat. What is more difficult to accomplish, the edible portions of the gastrointestinal tract are separated from it without being contaminated by its contents. The inspector in the slaughtering department, therefore, not only detects lesions of animal diseases and has a knowledge of their significance concerning the disposition of the carcasses which he inspects, but he supervises personally the dressing of each carcass to assure that at each step in the operation every precaution is taken to preclude contamination of the meat.

The construction of the slaughtering department, its equipment, and the layout of the department bear a direct relation to the maintenance of sanitary conditions there. In spite of the best efforts of an inspector, good results are not possible where there is faulty construction, inadequate equipment, or poor layout. The slaughtering department is constructed so as to facilitate the maintenance of clean conditions. There is sufficient and properly designed equipment to permit efficient and clean operations and to permit the slaughtering department being readily cleaned. The layout is such as to assure smooth flow of operations. Adequate light, both natural and artificial is provided. Good light is important not only as a necessity for the conduct of the inspection but it also makes easier the maintenance of a clean condition throughout the entire department.

Facilities are provided for periodical cleanups during the slaughtering operations.

The equipment necessary for proper handling of the carcass and its products during the slaughtering operation is quite specialized. For example, it is necessary that the hog scalding vat be supplied with hot water at just the proper temperature for scalding the hog carcass effectively. This vat is the correct length considering the rate of kill, to permit submerging the carcass long enough to get the desired results. Also, this vat is so installed and located that the steam from the large quantity of

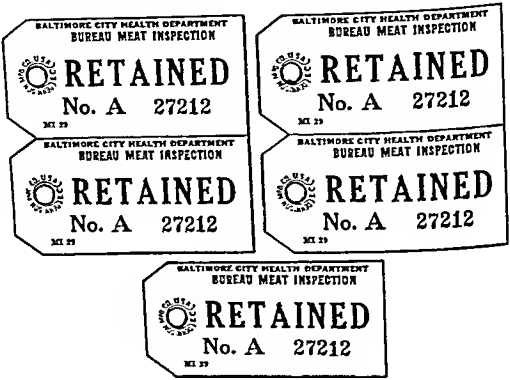


FIG. 3 —Gang of five "Retained" tags

hot water which it holds will not interfere with normal slaughtering operations, inspection procedures, and the like. As another example, the rails for conveying the hog carcass through the slaughtering operations are of the right height with respect to the operating levels, so as to facilitate the efficiency of each dressing operation performed on the carcass while it is suspended from the rail, and at the same time avoid contamination of the carcass which would occur should it come in contact with the floor or other fixed objects. Structural details which have a bearing on the sanitary operation of a meat packing plant and the facilities for inspection are dealt with in chapters 7 and 8, pp 195 and 263.

Post-mortem inspection of food animals is based on the routine examination of the head and cervical lymph glands, the visceral and body lymph glands, the organs of the viscera, and the exposed portions of the carcass. A more minute examination is made of the organs and parts of carcasses

depending on the condition found during the routine examination or when the carcass is that of an animal identified as a suspect on ante-mortem inspection.

When a disease or other abnormal condition is found during the routine post-mortem examination, the carcass and its parts are retained for a final examination which is more extensive than would otherwise be given the carcass. Tags bearing the word "retained" are affixed to the various portions of the carcass and its viscera which become separated during

Fig. 4.—An unfit hog carcass being branded "U. S. Insp'd and Condemned."

the dressing operation so that they may be assembled for the final examination. In the case of cattle retained for final examination, a so-called gang tag is used consisting of 5 identical "retained" tags each bearing the same serial number. One tag is attached to the head, a tag is attached to each half of the carcass, and one is used to identify the viscera. The remaining tag is held by the inspector as a record of the retention. For final examination all portions of the carcass and its viscera are assembled

in a space set apart in the slaughtering department especially for this purpose.

In those cases where the abnormal condition is benign and localized and one in which there is every reason to believe there is no similar involvement anywhere else in the carcass, the inspector disposes of the localized condition summarily. If no other abnormal condition is found during the inspection, the normal portions of the carcass and its parts are passed for food without requiring it to be retained for final examination.

Carcasses, parts of carcasses, and accompanying viscera which are found to be unfit for food are condemned by the inspector and under his supervision are made unavailable for food by placing them in the fertilizer tank or by similar handling.

**Cattle.**—The stunning of cattle with the use of a long-handled hammer as was usually practiced in the United States is giving way to mechanical devices which propel a captive bolt by the explosion of a small blank cartridge. There are several modifications of the captive bolt device which are principally concerned with the shape of the impact and of the captive bolt, and the grip or handle used by the knocker. The knocker grasps a handle similar to that of an ordinary pistol or a long straight handle which enables him to place the stunner in a knocking position without bending over the head of the animal. The bolts that are designed to penetrate the skull into the brain sometimes carry particles of skin and hair into the brain tissue. Brains so contaminated are regarded as being unfit for food. Attempts to salvage brains so contaminated have not been successful because the removal of the skin particles and the hair is not accomplished with any degree of certainty. The penetrating bolt enters the brain in variety of angles and depths.

The electrical methods for stunning both large and small animals have been employed in Europe and England for many years. Various kinds of apparatus are used and their efficiency is mainly judged by practical results. If electrical stunning is to be effective, the current must pass through the brain. Because the brain of animals is relatively small, the electrodes must be accurately sited on the head of the animal, if the stunning is to, in fact, effect unconsciousness, rather than a mere paralysis with the animal still being conscious of pain.

The irregularity of the external surface of the skull often makes it impossible to apply the electrodes at the ideal site. Bone is a poor electrical conductor, thick portions of the skull are unsuitable therefore for the application of electrodes.

Successful stunning depends on the passage through the brain of an adequate amount of electricity in a sufficiently short period of time. This in turn depends largely on the voltage applied and the resistance. In practice, a transformer is used that delivers 70 to 80 volts. The electrodes must make adequate contact with the skin of the animal. This is influenced by a number of things among which are the pressure with which the electrode is applied, the hair coverage of the area, whether the area is wet or dry, and the presence or absence of such things as caked mud. Water or salt solution is sometimes used to assure good passage of current from the electrode to the skin. Care is exercised to assure against splashing the water

or salt solution over the face of the animal since this would provide an alternative current path and short-circuit the brain.

It is important that certain rules be observed if electrical stunning is to be used effectively and humanely on food animals. There should be no delay between stunning and bleeding since this increases the hemorrhaging in the carcass and its organs, and allows the possible development of a state similar to that of curarization. The apparatus must be maintained in good repair. Corroded electrodes is a common cause of increased resistance and delivery of decreased current to the animal. The operator must apply the electrodes to the right part of the skull and they must be applied firmly.

If blood is to be saved for use as human food, there is provided a covered container having a spout, the end of which is inserted into the stick wounds and diverts the blood into the container. In order to prevent coagulation of the blood in the container, a solution of one part of citric acid or sodium citrate in two parts of water is first placed in the container. Only a small amount of this solution is required and it is not used in an amount to exceed 0.2 per cent of the solution in the amount of blood to be saved. To use more of the solution than is necessary to accomplish the purpose is considered adulteration.

Possible sources of contamination of the blood are from the hide and the probability that the esophagus may be punctured or severed by the incision. The receptacle for catching the blood is therefore completely enclosed except for the spout which is inserted in the incision beneath the cut surfaces of the skin. The esophagus is invariably severed when the kosher method of bleeding is used. In this case, if edible blood is to be saved, a heavy pair of forceps is clamped over the cut end of the esophagus on the paunch side to prevent regurgitation which sometimes occurs while the animal is bleeding. The blood of each animal is identified with its carcass so that should any condition subsequently be found on post-mortem examination of the carcass which would require its condemnation, the blood can then also be destroyed.

After the bleeding of the animal and while the carcass is still hanging from the chain shackled around the hind legs, the head is skinned and removed from the carcass. This skinning is conducted with the care necessary to avoid contamination of its skinned surface by the hide. For the same reason the skinned head is removed promptly from the carcass. As the skinned head is severed from the carcass, it is held securely by the operator so that it is not contaminated by contacting the floor. As the head is removed from the carcass, there is attached to it one section of a two-section identification tag, the other section being attached to the neck of the carcass. This maintains the identity of the head with the carcass since the disposition of the head finally will be determined by the condition of the carcass found on post-mortem examination and its final disposition.

The skinned head is then placed on a rack or a hook located in a cabinet directly connected with a drain. This cabinet controls all splashing which occurs while the head is being cleaned by washing with water under high pressure. At this point the horns are removed from the head. Particles of skin which might have been missed in the skinning and left adhering to the head are also removed. The outside surfaces of the head are thor-

oughly cleaned, and the oral, nasal, and pharyngeal cavities thoroughly flushed of their contents. The washed head is then placed on a hook or a rack which separates it from the other heads to facilitate its inspection.

The inspector first examines the head to see that it has been properly cleaned. At the same time he detects any abnormal condition on the outside surfaces of the head, such as enlargements, abscesses, and the like. He then exposes and examines by incising repeatedly both mandibular lymph glands. These glands are located superficially in the lower portion of the mandibular space between the inner aspects of the mandible and the mandibular salivary glands about 2 inches anterior to the point where the lower border of the mandible curves abruptly upward and above the anterior attachment of the sterno-cephalicus muscle. Usually, there is but 1 gland on each side but at times there are 2 glands lying very close to each other (Fig. 5). To expose the gland, a longitudinal incision is made along the inner border of the sterno-cephalicus muscle just within the lower border of the mandible where the gland will be seen adjacent to the salivary gland.

The suprapharyngeal lymph glands are next exposed and examined by making repeated incisions in the glands. These lymph glands are located at the base of the cranium just superior to the pharynx lying close together on each side of the median line between the branches of the hyoid bone (Fig. 5). These glands average about 2 inches in length. They are exposed by first drawing the larynx forward and downward and then a deep transverse incision is made near the base of the cranium. This will reveal the glands lying on the superoposterior surface of the pharynx.

The plant employee removes the thyroid glands and the parathyroid glands before he proceeds with dropping the tongue which prepares the head for further inspection. These glands are saved for the production of pharmaceuticals. The thyroid gland consists of two maroon-colored masses on either side of the trachea and close to the larynx. These masses are bridged by a narrow isthmus of the same tissue. The parathyroid glands are located near the thyroid gland. The number found in individual animals varies considerably. These glands are sometimes imbedded within the substance of the thyroid gland and sometimes directly behind it on the trachea. They are about the size of a wheat seed.

The tongue is dropped by first severing the hyoid bones with a cut made by a cleaver transversely at the base of the cranium. The tongue is then cut free from the base of the cranium and the interior surfaces of the mandible, leaving it attached at the symphysis of the mandible from which the tongue is permitted to hang free. The tonsils are removed from the base of the tongue and disposed of as inedible. Occasionally, cut portions of the tonsil are left remaining on the skull when the base of the tongue is removed from it. These particles of tonsil are trimmed from the skull and discarded as inedible to avoid their being included with the head meat when the head is boned.

The inspector examines the tongue for abnormalities by observing its surface and by palpation. Local conditions, such as scars and hair sores, are trimmed from the tongue. Abscesses are detected by palpation.

The inspector slices the interior and exterior masseter muscles parallel

to the plane of the mandible, to their attachments at the zygomatic process. The cut surfaces of these muscles are examined for parasite cysts. The parotid lymph glands are repeatedly incised for examination as part of this operation. The parotid lymph gland is located at the superior anterior border of the parotid salivary gland being partly imbedded in the salivary gland and partly lying on the masseter muscles about 1 inch in front of and a little lower than the external meatus of the ear.

The head which has passed inspection is held until post-mortem examination of the carcass is completed. When the carcass also passes the inspec-


Fig. 5.—Bovine head in position for inspection (lymph glands exposed).
*A*, Mandibular lymph gland; *B*, parotid lymph gland; *C*, suprapharyngeal lymph gland; *D*, atlantal lymph gland; *E*, hemolymph gland.

tion, the head is removed from the inspection position to the point where it is worked up by the plant employees. The tongue is first removed and each tongue is washed individually before being placed in the truck or other container which conveys the tongues to the cooler.

After the tongue is removed any meat and fat left on the skull is trimmed from it. This is known as head meat. The meat and other tissue removed from the interior and exterior surfaces of the mandible are referred to as beef cheeks. When these cheeks are trimmed by removing the parotid salivary gland, and lymphoid, and fatty tissue, the resulting product is called cheek meat. The soft palate and lips are also removed and saved as edible product.

The skull is split and the brain removed. The pineal and pituitary glands are removed from the base of the brain and saved for pharmaceutical purposes. The pineal gland is a cone-shaped bit of tissue hidden away at the base of the brain in a tiny case behind and above the pituitary gland. The pituitary gland is located at the base of the brain. It is about the size of a hazel nut and of pinkish color. It consists of anterior and posterior lobes.

After the head is removed the carcass is lowered to the dressing bed where it is placed on its back and is propped up either by a short iron rod called a "pritch" or by using a cradle.

The legs are skinned and removed from the carcass at the carpal and tarsal joints. The legs are all removed after the carcass is placed in the dressing bed, since an attempt to remove the forelegs while the carcass is suspended from the bleeding rail opens up the shank and carpal regions to probable contamination as the carcass is lowered into the bed. The preferred practice in skinning the legs prior to their removal is to leave the dewclaws attached to the skin, which avoids the accumulation of detached dewclaws in the dressing bed area.

After the legs are removed, the carcass is opened by cutting along the median line from the neck through the crotch. This incision is deep enough to open the abdominal cavity. In opening the carcass, care is exercised to avoid puncturing the paunch, intestines, or bladder, since their contents would constitute a serious source of contamination. The esophagus is raised, separated from the trachea and it is then ligated so as to prevent escape of the paunch contents during subsequent handling. The trachea is likewise loosened from its natural attachments so that its removal with the lung will be easy when the carcass is eviscerated.

The skinning of the ventral surface of the carcass progresses at this point and includes the skinning of the shoulders and the thighs. The principal source of contamination during this operation is connected with the removal of lactating udders. Care is exercised to leave the skin in the area of the teats intact, and the skin is removed from the udder without puncturing the glandular tissue. After being skinned, the udder is removed from the carcass and here again care is exercised to avoid puncturing the glandular tissue. Furthermore, removal of the udder is accomplished leaving the supramammary glands intact and attached to the carcass. The pelvis is opened at its symphysis and the thorax is opened by sawing through the brisket on the median line. In sawing the brisket, the point

of the saw is directed toward the neck rather than toward the abdomen. This is done to avoid contamination which might result from the saw puncturing any of the viscera or contacting any disease process, such as an abscess in the liver.

The carcass is next raised slightly off the floor by the back legs to a position known as "half hoist." This position leaves the shoulders resting on the floor and places the carcass at the proper height for the plant employee to remove the hide from the rump. The first step in this skinning

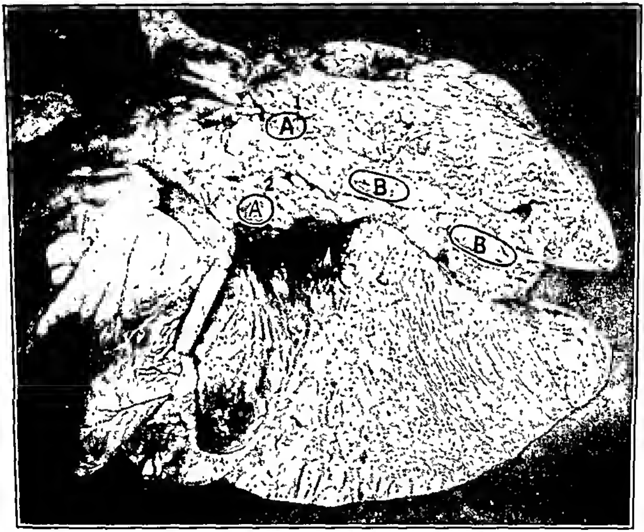


Fig. 6.—Thoracic viscera of cattle.
*A*, Bronchial lymph glands (right and left); *B*, mediastinal lymph glands.

operation is to clear out the hide around the rectum. Care is exercised to avoid puncturing the rectum, and after it is separated from the hide and loosened from the walls of the pelvic cavity it is ligated to avoid contamination which would result from escape of its contents. The tail is skinned out next and this must be done carefully to avoid contamination of the surface of the skinned tail by the hide and hairs as the skin is removed. After the rump is skinned, the carcass is raised further to hang free of the floor so that the viscera can be removed and placed in appropriate equipment for inspection.

The viscera is separated into the thoracic viscera, the paunch including

the other stomachs, and the intestines. As the stomachs are removed from the intestines, both ends of the cut duodenum are ligated to avoid escape of its contents and possible contamination. As the viscera is presented for inspection the lumen of the intestinal portion has been tied off at the duodenum and again at the rectum and the stomach portion has been tied off at the esophagus and duodenum.

Routine inspection of the viscera starts with an observation of its general condition. Then the bronchial lymph glands are incised repeatedly and examined for indication of disease. The right bronchial lymph glands are about four in number and are located at the juncture of the bronchus of the right apical lobe and the juncture of the main lobe with the trachea. The left bronchial lymph gland is located on the left side of the trachea anterior to and near the left bronchus and is normally the largest of the bronchial lymph glands. The posterior mediastinal lymph glands are then incised repeatedly and examined. These glands extend from the aortic arch posteriorly to the diaphragm. They consist of two main groups. The anterior is the smaller group sometimes called the medium mediastinal glands. The lymph glands of both groups vary in size.

The lungs are palpated to detect any abnormal condition that may be present.

The heart is next examined by making in it a longitudinal incision extending from its base to the apex through the wall of the left ventricle and the interventricular septum. The outside and inside surfaces of the heart are then examined as well as the cut surfaces to detect any indication of the presence of parasitic cysts.

The liver is then examined by first observing and incising repeatedly the portal lymph glands. These glands, from three to five in number, are located on the posterior surface of the liver and are imbedded in the fatty cushion surrounding the vessels entering at the portal fissure. The large bile duct is then opened longitudinally and examined for indications of parasitic infestation. The liver is palpated for the purpose of detecting any abnormal condition whether located superficially or deeply in the organ.

The remainder of the abdominal viscera is then examined by first observing the mesenteric lymph glands. These are incised in case an abnormal condition is found. The mesenteric lymph glands are located in the mesenteric fat along the lesser curvature of the intestines in the folds of the mesentery and consist of a continuous chain of glands from the abomasum to the cecum. They are cylindrical segments and vary in size and consistency according to the stage of digestion, being more voluminous and containing a greater fluid content immediately after or during the digestive period. The spleen is palpated and incised when necessary for a complete examination.

Attention is given to the external surface of the reticulum since abscesses caused by punctures of foreign bodies in that organ frequently occur.

Following evisceration, the hide is removed from the back of the carcass as far as the shoulder region or "chuck." The rump and back are then split and the carcass is elevated to the overhead rail on which it travels eventually to the cooler. The hide is next removed from the shoulder and neck and dropped to the floor. The chuck and neck are split and the

carcass hangs in two halves or sides. The hide is removed to a conveniently located chute through the floor which conveys it to the hide cellar. Care must be exercised to see that the hide is handled in such a way as not to contaminate any edible portions of the carcass.

FIG. 7.—Federal veterinary meat inspector demonstrating inspection technique on bovine viscera for students attending a class on food hygiene conducted by the U. S. Navy. (Official United States Navy Photograph.)

The last dressing operation before the halves move to the rail inspection position and final washing is known as "scribing." This consists of breaking the dorsal processes of the vertebræ along a line parallel to the back starting on the second vertebræ of the loin about three-fourths of an inch from the dorsal surface, downward across the dorsal processes of the thoracic vertebræ on a slight angle. This is done for the purpose of improving the appearance of the sides.

Each side of the carcass is next examined at what is referred to as the

rail inspection position. The term "rail" is used to designate the inspection conducted on each carcass as it hangs from the rail. It consists of observing all surfaces of the carcass and includes palpation of the prescapular, prefemoral, superficial inguinal (supramammary), internal iliac, lumbar, and renal lymph glands. The prescapular lymph gland is located a little above and inward from the shoulder joint imbedded in a cushion of fat and covered by the brachiocephalicus muscle. It is a large gland and elliptical in shape. The prefemoral lymph gland is situated on the aponeurosis of the obliquus abdominis externus muscle, in contact with or close to the tensor fasciæ latæ and 5 or 6 inches above the patella. It has an elongated elliptical outline and is flat. The superficial inguinal lymph glands are located at the neck of the scrotum beside the penis in front of the inguinal ring; they are imbedded in the scrotal fat in castrated males. The supramammary lymph glands are situated bilaterally at the posteriosuperior part of the mammary gland. The internal iliac lymph glands are large heart-shaped glands 2 or more inches in diameter located in about the upper third of the pelvic arch in the obtuse angle formed by the external iliac artery and the abdominal aorta. The lumbar lymph glands are located in the sublumbar region along each side of the abdominal aorta and are usually imbedded in the fatty cushion bordering the large blood vessels of the sublumbar region. The renal lymph glands are located in the fatty tissue in the hilus of the kidney on the course of the renal artery.

The region of the kidney and the crura and flat portion of the diaphragm are observed and palpated. The pelvic cavity is observed, particularly, to make certain that no portion of the genitalia has been left remaining on the carcass.

Those carcasses which pass inspection at this point and which have not been retained for any condition on previous inspection are thoroughly washed, and then they are ready for the cooler. After being washed and before being placed in the cooler, many meat packing plants clothe the external surface of each beef side. The side is covered with a warm, damp sheet of heavy muslin (40 inches wide, 48x48, 2.85 yards to the pound). This cloth is stretched tightly around the thigh and down over the flank and outside surface of the carcass, being securely pinned along the cut median line and the vertebral column. The cloth is removed from the side after chilling, giving it a smooth and bleached appearance. Before these cloths are used again, they are washed thoroughly by first soaking to remove any blood stains, laundered, and then treated with a solution of sodium hypochloride to accomplish a degree of sterility.

After the abdominal and thoracic viscera have passed the inspection, they are removed to the viscera separating area. The unit referred to as the "pluck", which consists of the lungs and heart, is hung up by the trachea for separating into its various parts. The fatty tissue making up the pericardial sac is removed and saved as edible fat. The heart is separated from the lung and the large arteries are cut away. These arteries are handled as inedible. The trachea is removed from the lung; the trachea is also inedible. If the lungs are to be saved for food, the plant employee opens up the large bronchi by splitting them longitudinally.

Lungs so prepared are hung on racks for further inspection. In those cases where any foreign substance is located in the bronchi, the lungs are condemned. The liver and spleen are edible products.

The unit consisting of the stomachs is placed on a table where the first operation performed by the plant employee consists of removing the omental fat which is saved as edible. Next, the rumen and reticulum are separated from the omasum and abomasum. The omasum and abomasum are handled as inedible, while the rumen and reticulum, which together are known as the paunch, are emptied of their contents as the first step in their preparation as tripe. The esophagus is removed and flushed of its contents; the muscular coat is separated from the mucous lining. The muscular coat is known as gullet meat, an edible product. The mucous lining is one of the animal casings and is known as the weasand.

After being emptied of its contents, the paunch is thoroughly washed by spreading it with the mucous side up over a cone-shaped table. A water spray located above this table assists in the thorough scrubbing of the entire mucous surface. This cone-shaped table revolves to facilitate the washing process. The washing continues until the water squeezed from the cleaned surface is as clean as the wash water itself. The paunch is then turned over with the peritoneal surface up. This surface is also thoroughly washed, and trimming of soiled loose connective and fatty tissue is sometimes necessary to completely clean the article.

The cleaned paunches are hung up for inspection before they are scalded. The scalding of the paunches is done primarily to remove the superficial surface of the mucous membrane. This is performed by placing a number of clean paunches in a revolving washer of special design partially filled with hot water to which a detergent has been added. The temperature of the water is approximately 150° F. and the detergents used are caustic soda, sodium carbonate (soda ash or sal soda), trisodium phosphate or sodium metasilicate or a combination of these substances, or lime, or a combination of lime and sodium carbonate. Hydrogen peroxide is also sometimes used either singly or in combination with one or more of the detergents. The removal of the superficial surface of the mucous membrane is accomplished by the combined action of the detergent solution and the rubbing action produced by the revolving of the cylinder. After the desired result has been obtained, the detergent solution is drained from the equipment and the product is rinsed thoroughly with clean water while the machine is still revolving. This produces the product known as uncooked tripe which is chilled and is ready for further processing.

The unit consisting of the large and small intestines is handled on another table. First, the small intestine is removed from the mesenteric fat by a method which is referred to as "running." This is accomplished by cutting the small intestine loose from the fat which enmeshes it to the point where it joins the large intestine. The contents are promptly stripped free from the small intestine under a spray of water which washes the contents immediately into a drain. This protects the intestine from contamination. The intestine has considerable fat adhering to it at the point on the surface where the intestine was attached to the mesenteric fat. This fat is removed by passing the intestine through two revolving

cylindrical brushes. These brushes play against the surface of the intestine and remove the fat. If this fat is intended to be saved for the production of edible rendered fat, care is exercised to see that none of the contents of the intestine which might have remained after stripping enters the receptacle in which the fat is collected and thereby contaminate it. The small intestine is then turned inside out and passed through a machine which removes the superficial mucous surface. Usually the intestines go through a series of these so-called "sliming" machines after which they are taken to the casing department.

The cecum is removed from the large intestine just posterior to the ilio-cecal valve. It is then flushed of its contents, care being exercised to direct the contents directly to the drain so that they will not contaminate the outside of the cecum. The fat is removed and the cecum is then sent to the casing department. The fat, if clean and properly handled, is classed as edible and is used in the preparation of edible rendered fat.

The large intestine is also flushed of its contents. Water is run through the intestine until it comes out free of any indication of intestinal contents. The fat is removed from the large intestine which is then taken to the casing department. This fat, also, if clean and properly handled, is classed as edible and is used in the preparation of edible rendered fat.

**Calves.**—In some meat packing plants, calves are stunned like cattle before shackling and hoisting for bleeding while in other plants they are hoisted and bled without stunning. Whether or not the calf is stunned, it is shackled by one hind leg and hoisted to the rail along which it travels to the bleeding position. The incision for bleeding is made at a point at the right side of the neck just below the jaw, severing the blood vessels there. When the kosher method of slaughtering is employed, the blood vessels are severed by drawing a sharp knife transversely across the neck just posterior to the angles of the mandible.

There are two methods of dressing calves in the United States. One is with the hide on, the other with the hide removed.

When the carcass is dressed with the hide on and it has been slaughtered by the kosher method, the head is removed immediately after the animal has been bled. This is necessary to avoid contamination of the exposed cut surface of the head which would occur during the washing of the hide as part of the dressing operation. After the head is removed, it is thoroughly washed in a suspended position with the cut surface down so that the water used in washing the skin of the head will drain away from it without contaminating the cut surface. The oral and nasal cavities are flushed and the cut surface of the head is thoroughly cleaned and trimmed when necessary to eliminate any soiled tissue. The head is then placed on a rack or hook for inspection. The inspector observes the head for cleanliness and any abnormal condition and he incises repeatedly the suprapharyngeal lymph glands as part of his examination. The heads are then held until the carcasses pass inspection.

The carcass with head removed in the case of kosher kill or the carcass with head attached in the case of regular kill is then thoroughly washed while it is suspended from the rail by the shackle. Except for the incision

made for bleeding and the removal of the head in the case of the kosher method of slaughter, no incision is made in the carcass until the hide has been thoroughly cleaned. This is usually accomplished by washing the hides of the carcasses with water under very high pressure. Also, curry combs are used where necessary to dislodge any dirt. Next, incisions are made dorsal to the tarsus in which the gambrel is inserted and the carcass is hung off from the shackle rail to the dressing rail. The feet are now removed and the carcass is prepared for evisceration.

When the hide is removed as part of the dressing operation, the hind legs are removed immediately after bleeding and while the carcass is hanging from the shackle. The shanks and thighs are skinned. Incisions are made dorsal to each tarsus for insertion of the gambrel and the carcass is then hung off to the rail from which it is suspended on the gambrel. The skinning of the carcass proceeds as it hangs from the gambrel by first skinning the ventral side and, then, by a combination of skinning and pulling, the hide is removed from hip and back. The forelegs have been removed in the meantime and the skin is removed from the shoulder, neck, head (if attached) and dropped to the floor.

The carcass is opened by cutting along the median line from the pelvis to the neck. The rectum is loosened from the pelvic cavity and it is ligated along with the bladder; also, the penis is removed. As part of the preparation of the carcass for evisceration, the thymus gland is dissected away from the neck and left attached to the trachea. The esophagus is loosened and ligated so that it may be readily removed with the abdominal viscera without any contamination which might occur from regurgitated material or result from tearing the esophagus away from its attachment to the rumen.

After the carcass is prepared for evisceration it passes to the inspection position. If it is a carcass with head attached, the head is first removed and placed on appropriate equipment for inspection. The thoracic viscera, the liver, and the spleen are removed from the abdominal viscera as the viscera is presented for inspection. The eviscerator must exercise every precaution to avoid cutting into any of the abdominal viscera, the contents of which would be a serious source of contamination for the edible portions of the viscera. In handling small calves the stomach portion of the abdominal viscera is not usually separated from the intestinal portion. It is preferred that abdominal viscera be removed intact so that the ligations of the esophagus and the rectum will completely safeguard against contamination by their contents. In large calves when it is necessary to separate the stomach portion from the intestinal portion, ligations are made where the duodenum is to be severed before the evisceration is performed. Routine viscera inspection consists of an observation of all of the viscera as it is presented for inspection. The bronchial, mediastinal, portal, and mesenteric lymph glands are palpated. Also, the heart, lungs, liver, and spleen are palpated and all surfaces observed.

When a condition is found by the head inspector or the viscera inspector which requires additional inspection, the bronchial, mediastinal, portal, and mesenteric lymph glands and the spleen are incised repeatedly as part of their examination. When a condition is found on inspection which

requires the final inspection of the carcass, its viscera, and the head, they are assembled in a space set apart and equipped for final inspection.

Carcasses which pass inspection proceed to the cooler after they are given a final washing. The hides of carcasses dressed with the hide on are not washed at this time because of the danger of washing hair into the interior of the carcass. The washing of such carcasses is confined to flushing out the abdominal and thoracic cavities.

The thoracic and abdominal viscera of calves which passed inspection are handled very much the same as has been described for cattle. The thymus gland or sweethread of calves is an entirely different commodity from the vestige of the thymus gland sometimes obtained from fat cattle. Another difference is the abomasum which is saved from very young calves for the production of rennin. These abomasi are not saved and handled as edible product since such handling would destroy their rennin content. Their content is only roughly removed and then they are salted down aad shipped to the plants where they are used as a source of rennin.

Calf heads are prepared for sale in several ways. Some are chilled whole with the skin on without any further preparation. Others are skinned and the whole head chilled and sold as such. Some calf heads are skinned after which the tongue, cheek meat, and brains are removed. In this case, after removing the tonsils, the tongue, the cheek meat, and the brains are saved as edible products while the bones in the skull and jaws are handled as inedible.

**Swine.**—In the United States swine are not stunned before bleeding. The animals are driven ioto a shackling pen which handles only several at a time and permits the shackler to work close to the hoist. The shackler secures the shackle chain around the hind leg of each animal holding the free end of the chain as he attaches it to the hoist which elevates each animal to the bleeding rail. This rail passes through the sticking pen and here each animal is bled through a stick wound which severs the blood vessels in the lower part of the neck. The opening through the skin is kept as small as is possible and consistent with complete bleeding of the animal. This is important to hold to a minimum the contamination of this area with water as the carcass passes through the scalding vat.

The placing of a shackle chain around the hind leg of a live hog and securing the loose end of the chain to a conveyor which carries the live animal to the bleeding rail is an arduous task. It is hard, hazardous work and the meat packing industry experiences difficulty in manning these positions. Recognizing this, the George A. Hormel and Company at Austin, Minnesota, has developed a method whereby carbon dioxide is used immobilize the live hog and thereby eliminating this hazardous manual shackling operation.

The use of carbon dioxide in human therapy led to the study of the effect of the gas on the nervous system. Although investigations have only partly answered the many questions which arise, a few observations have been made which can explain some of them. It is known that an isolated nerve in a high carbon dioxide tension requires greater irritation to react, that is, to send out impulses. It is also known that under these circumstances the speed of the impulse along the nerve is reduced. Carbon

| Cause of Condemnation | *Number of carcasses of* Cattle | Calves | Sheep and Lambs | Goats | Swine | Horses |
|---|---|---|---|---|---|---|
| Degenerative and dropsical conditions: | | | | | | |
| Anasarca | 723 | 17 | 233 | | 13 | 1 |
| Emaciation | 7,547 | 7,943 | 15,957 | 215 | 255 | 248 |
| Hyaline degeneration | 17 | 1 | 77 | | 120 | |
| Hydropic degeneration | 326 | 9 | 67 | | 389 | 4 |
| Miscellaneous | 88 | 7 | 7 | | 182 | 9 |
| Infectious diseases: | | | | | | |
| Actinobacillosis and actinomycosis | 1,035 | 23 | | | 2 | |
| Anaplasmosis | 212 | 24 | | | | |
| Anthrax | | | | | 18 | |
| Blackleg | | 2 | | | | |
| Brucellosis | | | | | 21 | |
| Caseous lymphadenitis | | | 12,337 | 188 | | |
| Swine erysipelas | | | | | 4,109 | |
| Hog cholera | | | | | 2,265 | |
| Johnes disease | 2 | | | | | |
| Necrobacillosis and necrosis | 93 | 15 | 6 | | 17 | 1 |
| Texas fever | 1 | | | | | |
| Tuberculosis nonreactor | 178 | 2 | 29 | | 7,774 | |
| Tuberculosis reactor showing lesions | 303 | 4 | | | | |
| Miscellaneous | 18 | 9 | 4 | | 8 | |
| Inflammatory diseases: | | | | | | |
| Enteritis gastritis peritonitis | 5,581 | 4,393 | 670 | 3 | 5,792 | 29 |
| Mastitis | 2,550 | | 18 | | 52 | |
| Metritis | 3,662 | 6 | 326 | 1 | 1,227 | 12 |
| Nephritis | 3,246 | 651 | 482 | 5 | 2,000 | 9 |
| Pericarditis | 7,988 | 154 | 232 | | 1,003 | 6 |
| Pleurisy and pneumonia | 11,223 | 6,507 | 14,674 | 19 | 18,147 | 179 |
| Miscellaneous | 349 | 248 | 424 | 1 | 707 | 15 |
| Neoplasms: | | | | | | |
| Carcinoma | 1,602 | 15 | 46 | | 265 | 8 |
| Epithelioma | 2,922 | 5 | 2 | | 10 | |
| Malignant lymphoma | 2,998 | 154 | 79 | | 1,009 | 7 |
| Sarcoma | 411 | 7 | 9 | | 253 | 18 |
| Miscellaneous | 1,622 | 48 | 97 | | 837 | 34 |
| Parasitic conditions: | | | | | | |
| Cysticercosis | 133 | 13 | 467 | | 23 | |
| Stephanuriasis | | | | | 714 | |
| Miscellaneous | 1,395 | 31 | 885 | | 14 | |
| Pigmentary conditions: | | | | | | |
| Melanosis non-malignant | 35 | 52 | 86 | | 403 | 117 |
| Xanthosis | 55 | | | | 3 | |
| Miscellaneous | 10 | 2 | 9 | | 94 | |
| Septic conditions: | | | | | | |
| Abscess or pyemia | 9,311 | 1,221 | 2,532 | 91 | 16,063 | 78 |
| Septicemia | 6,171 | 2,254 | 1,694 | 9 | 10,147 | 21 |
| Toxemia | 490 | 161 | 162 | 1 | 894 | 2 |
| Miscellaneous | 54 | 56 | 8 | | 54 | 1 |
| Arthritis | 687 | 1,100 | 2,085 | 1 | 15,714 | 1 |
| Asphyxia | 20 | 53 | 41 | | 2,069 | |
| Bone conditions | 35 | 11 | 5 | | 289 | |
| Contamination | 7 | 15 | 18 | | 2,865 | 1 |
| Icterus | 438 | 1,576 | 2,908 | 7 | 15,661 | 3 |
| Immaturity | | 10,757 | 8 | | 13 | 2 |
| Injuries | 4,300 | 1,561 | 1,128 | 13 | 2,306 | 53 |
| Pregnancy advanced or recent parturition | 111 | | 3 | | 9 | 1 |
| Sexual odor | | | | | 4,312 | |
| Skin conditions | 9 | 4 | 2 | | 103 | |
| Uremia | 1,078 | 97 | 1,319 | | 697 | 2 |
| Hyperkeratosis | 3 | | | | 4 | |
| Miscellaneous general | 72 | 7 | 29 | | 105 | |
| Total | 79,141 | 39,215 | 59,185 | 554 | 119,034 | 865 |

FIG. 8 —Number of Carcasses Condemned for Various Diseases and Conditions on Postmortem Inspection, Fiscal Year 1956, Federal Meat Inspection

dioxide also has the effect of making the transfer of impulses from one nerve ending to another more difficult because the connections between the endings are partly blocked by the high carbon dioxide concentration. These circumstances make carbon dioxide an effective anesthetic.

Experience acquired in connection with studying the physiological effect of carbon dioxide on humans involved the use of 30 to 35 percent carbon dioxide and 70 to 65 percent oxygen. To immobilize swine the most

FIG. 9.—Anesthetized hog emerging from carbon dioxide chamber ready for bleeding (George A. Hormel & Co., Austin, Minn.).

effective combination has been found to be 65 percent carbon dioxide mixed with atmospheric air. Those who have developed the carbon dioxide method of immobilizing swine are of the opinion that the animals suddenly lose consciousness about fifteen seconds after they are put into the carbon dioxide atmosphere and that the animal quickly becomes generally anesthetised.

It is essential that the system be adjusted carefully so that anesthetising

is the result of the treatment and not suffocation. It has been shown that the carbon dioxide immobilizing operation can be run under practical packinghouse conditions to accomplish the desired results. It is a matter of proper adjustment of the carbon dioxide concentration in the chamber in which the animal is anesthetised and proper timing of the exposure. It has been demonstrated repeatedly that the carbon dioxide anesthetised animal will in only a matter of a few minutes regain consciousness and return to normal.

The bleeding rail is long enough to permit holding each animal for sufficient time to assure complete bleeding before it is dropped into the scalding vat.

Considerable attention is given to the temperature of the water in the scalding vat, to the length of time each carcass is held in the scalding vat, and to the thoroughness with which the scalding water reaches all parts of the surface of the carcass. This is important since the thoroughness of the subsequent cleaning of the hog carcass depends on the scalding having been properly performed. If the scalding water is too hot, the surface of the skin is cooked which is not productive of a clean, smooth surface. If the water is too cool, the scurf and hair are not loosened which requires their being cut from the surface of the skin, again producing a surface which is not clean and smooth. The ideal scalding temperature ranges from 138° to 140°F. Generally, the length of time that the carcass is permitted to remain in the scalding vat is determined by tests made by the plant employee to determine whether the scurf and hair remove readily from the skin. The carcass is moved about and agitated in the scalding vat to make certain that the scalding water effectively acts upon the folds of skin in the pelvic and pectoral regions.

To maintain the supply of the large volume of hot water required in the scalding vat, recirculation of the scalding water is permitted, provided such water as must be added from time to time is clean and potable. The scalding vat is drained each day after the slaughtering operations and cleaned thoroughly. A fresh supply of clean, hot water is provided at the beginning of each day's operation. The carcass is placed in the dehairing machine when it is removed from the scalding vat. The hair and scurf which were loosened from the skin in the scalding vat are removed in a dehairing machine by friction produced by blades that beat the skin, and as the carcasses are crowded together, by the friction of one carcass upon the other. The carcasses in the dehairing machine are sprayed with hot water which removes the hair and scurf as they are rubbed free from the surface and facilitates generally the cleaning and polishing effect on each carcass.

The hot water used in the first two-thirds of the dehairing machine is recirculated, while the water used in the last one-third of the machine is not used again. All water used in cleaning the hog carcass beginning with the last third of the dehairing machine until the carcass is completely dressed is fresh, clean, potable water.

If the scalding and dehairing of the carcass has been properly performed, it is almost entirely free of scurf and hair as it leaves the dehairing machine. From this point, the carcass suspended from a gambrel inserted in the hind

legs proceeds on the dressing rail. It is first singed as part of the final cleaning of the carcass. From the singer, it proceeds to be shaved and is otherwise thoroughly cleaned before it is offered for inspection and before any incision is made in the carcass for the purpose of evisceration.

A special kind of singeing is performed on carcasses that are intended to be cut into English Wiltshire sides for export. In singeing for the domestic trade, the hair only is burned off without affecting the skin. For the export trade, the outer layer of the skin is scorched.


FIG. 10 – Head of hog in position for inspection (lymph glands exposed)
A, Mandibular lymph glands, *B*, parotid lymph glands; *C*, suprapharyngeal lymph glands.

Some meat packers supplement the work of the dehairing machine with an application of a mixture of rosin and oil to the carcass. This mixture which consists of approximately 15 per cent of paraffin oil or cottonseed oil and 85 per cent of rosin is held in a steam-heated storage tank. In some meat packing plants this mixture is applied only to parts of the carcass with large brushes. Other plants are equipped to immerse the entire carcass momentarily in the hot mixture. Where the carcass is immersed, precautions are taken to prevent the mixture from entering the mouth and nostrils of the carcass. After the mixture is applied, the carcass is sprayed immediately with cold water which sets the coating. This coating which possesses some elasticity due to the oil content of the mixture is then peeled off by hand from the surface of the carcass, and it takes with it any hair or scurf which was missed in the dehairing machine.

After the carcass has been thoroughly cleaned it passes to the head inspection position. If the head inspector finds that the carcass has been properly cleaned, he proceeds to an examination of the head and the cervical lymph glands. The mandibular lymph glands are incised repeatedly and examined for any abnormal condition. The inspector also examines the tissues exposed during the examination of these glands to detect evidence of cysticercosis, abscess, or other abnormal condition.

After the head inspection has been completed, the carcass moves to the area where it is prepared for evisceration. The rectum is first loosened and ligated to avoid contamination which would result from the escape of its contents during the subsequent handling of the viscera. The carcass is then opened by a longitudinal incision along the median line extending from the pelvic region to the neck. Care is exercised to avoid cutting into any of the viscera as the incision goes through the abdominal wall. Also, the incision must not cut into the prepuce. The incision severs the pelvis at its symphysis and opens the thorax along the median line. Next, the urinary bladder, the uterus, and the penis are removed, care being exercised again to avoid cutting into the prepuce. The content of the prepuce is a serious source of contamination should it be permitted to come in contact with edible portions of the carcass. As they are removed, all of these organs are handled as inedible.

The carcass is now ready for evisceration. The abdominal and thoracic viscera are removed together and intact. They are handled on equipment appropriate for their inspection. Care is exercised during the removal of the viscera to avoid cutting into it at any point which would permit its contents to escape. Also, the viscera is not permitted to become contaminated by contacting the floor or the standing platform used by the eviscerator.

The routine inspection of the viscera consists of palpating the bronchial, mediastinal, portal, and mesenteric lymph glands. Also, the liver, spleen, lung and heart are palpated for the purpose of detecting any condition which is not readily observed on their surface. It is necessary to manipulate the lung and liver so that all of their surfaces can be observed.

In those cases where an abnormal condition is found either by the head inspector or the viscera inspector which requires a more minute inspection, the bronchial, mediastinal, portal, and mesenteric lymph glands, and the

spleen are incised repeatedly as part of their examination. In those cases where the condition is such as to require a final inspection, the carcass and its viscera are moved to an area especially equipped and set aside for the conduct of final inspection.

Carcasses which pass the viscera inspection continue along the dressing rail to the point where they are split. A plant employee removes the kidney from its capsule and leaves it hanging in the carcass which prepares it for the rail inspection. The rail inspector observes all parts of the carcass. He sees that such benign local conditions as bruises, etc., are removed from the carcass by a plant employee. He examines the kidney and the surrounding area for evidence of parasitic infestation. He observes the exposed cut portions of the carcass for evidence of cysticercosis. He observes closely the perineal region for any abscesses or other abnormal condition resulting from castration. He observes the pelvic cavity to make sure that no portion of the genitalia has been left attached to the carcass during the dressing operation. Carcasses which he finds to be affected with some abnormal condition require final inspection and are retained by him for such examination. Those carcasses which pass the rail inspection move on toward the cooler, but first the head, leaf fat (parietal abdominal fat), and ham facings (fat from the inside surface of each thigh) are removed.

A few chilled hog heads are shipped to the trade just as they are removed from the carcass. Most of them are processed immediately. In either case there is no necessity for further cleaning the hog head, since its cleaning as part of the cleaning of the carcass during the dressing operation is calculated to produce a thoroughly clean hog head. Before the head is cut up into its several parts the oral and nasal cavities are flushed thoroughly so as to avoid contamination by their contents. Hog heads are cut up into skull fat, ears, snouts, lips, tongues, cheek meat, head meat, jaw meat, and brains; all edible products. The jaws and skulls are handled as inedible. Occasionally, the whole head is split longitudinally, leaving the skin over the dorsal surface intact. Such heads are then placed in cure. Before these heads are placed in cure the teeth and turbinate bones are removed to avoid them as a source of contamination in the cure.

Hog tongues require considerable attention to eliminate contaminated portions torn by the teeth during the scalding operation. These portions are trimmed from the tongue and handled as inedible. This is usually done at the same time the tonsils are trimmed from the tongue. Threadworms also are occasionally found in the mucous membrane of hog tongues.

After the viscera have been inspected they are passed to a separating table. The lungs are removed and handled as inedible. The heart, liver, and spleen are saved as edible. The heart is opened and emptied of coagulated blood. The opened hearts are then usually put in a tumbler for a brief period to wash them free of any remaining blood. The hog stomach is emptied of its contents and each stomach is washed individually. The clean stomachs are placed in a machine half filled with water at 120°F., where they are rotated for a period of about ten minutes. The stomachs are then completely rinsed by running fresh water through the machine.

The small intestines are pulled from their attachment to the mesenteric fat. They pull away from the mesentery without leaving any fat adhering

to them. The small intestine is immediately stripped of its contents under a spray of running water, using equipment which will dispose of the intestinal contents without danger of the intestines becoming contaminated with it. After the small intestine is stripped of its contents it passes through a machine which crushes and squeezes the mucous lining from its lumen. The intestine passes through a series of two such machines which are so equipped that the mucous or slime as it is discharged from the casing passes directly into the drainage system. The intestines are then taken to the casing department.

The terminal end of the large intestine is next removed from the abdominal viscera and is flushed free of its contents. This portion of the intestine is called the bung or bung gut and is taken to the casing department immediately after being flushed.

The cecum along with the remaining large intestine completes the digestive tract and this is also removed from the mesenteric fat. This intestine is flushed by placing it over long perforated stand pipes. A strong flow of water passes out of the end of this pipe and through its perforations to flush out the intestinal contents. This portion of the intestine is known as the chitterling and is handled as an edible product after being thoroughly cleaned both inside and outside.

The separation of the intestines from the mesenteric fat is so conducted as not to contaminate the fat with any of the intestinal contents. This fat is handled in a clean manner throughout and is used in the rendering of lard. The pancreas is sometimes removed from the mesenteric fat and saved for pharmaceutical purposes.

**Sheep.**—Because of their thick, heavy, wool covering, it is important to keep sheep and lambs free from mud and contamination before they are slaughtered. It is extremely difficult to avoid contamination of sheep and lamb carcasses during the dressing operations when the pelt is soiled.

It is not the practice in the United States to stun sheep, lambs, or goats. They are driven into a shackling pen where each is shackled above the foot on the right hind leg and hoisted to the bleeding rail. Except when the kosher method is used, bleeding is accomplished by inserting a sharp, pointed knife into the neck just below the ear and severing the blood vessels in that region. In the kosher method a sharp knife is drawn transversely across the neck just behind the angles of the mandible. Generally, sheep and lambs are skinned in connection with the dressing operation since it is very difficult to wash the pelt sufficiently clean to justify its remaining on the dressed carcass.

After the animal is bled, it moves on the rail still shackled by the right hind leg to the position where the free left hind leg is skinned. The foot is removed. The knife is inserted under the tendons on the posterior side of the metatarsal bones toward their distal end. The carcass is then transferred from the shackle rail to the dressing rail by a hook inserted through this opening. The right leg is then released from the shackle and it also is skinned. It is attached to a hook in the same manner as the other leg, leaving the carcass suspended entirely from the dressing rail.

Care is exercised in the skinning of the hind legs to avoid soiling the skinned portions of the carcass by contact with the wooly portion of the

pelt. It is the practice in some meat packing plants to cover the skinned portions of the hind legs with a protective sheet of parchment paper immediately after the pelt is removed.

The carcass is now hoisted by the feet of its forelegs to another rail which suspends the body nearly parallel with the floor. In this position the plant employee skins out the neck, shoulders, and the sides of the head. He also raises the esophagus and loosens it from its attachments as it passes through the thorax, ligating the cervical end at the same time. This facilitates removal of the esophagus along with the abdominal viscera when the carcass is later eviscerated. It also avoids probable contamination of edible portions of the carcass by such paunch contents as might gravitate down the esophagus with the carcass hanging in the inverted position. The trachea is also loosened to facilitate evisceration.

The forelegs are now released and the carcass is left suspended from the dressing rail by its hind legs. The rectum is loosened; however, it is not necessary that it be ligated inasmuch as the nature of its contents is such as to present no threat of contamination. The carcass is then completely skinned. The removal of the skin from the head presents the only real problem from the point of view of sanitation inasmuch as considerable care must be exercised in order to remove completely all of the skin from the face.

The carcass is prepared for evisceration by opening it along the median line. Here again it is necessary that care be exercised to avoid puncturing any of the abdominal viscera. The bladder, uterus, and penis are removed at this time.

Just before evisceration the duodenum is ligated at two points approximately 3 inches apart where it leaves the abomasum. The duodenum is severed between these ligations at the time of evisceration.

The lungs, heart, and liver are presented for inspection separate from the digestive tract portion of the abdominal viscera. This is presented together but separated into the stomach portion which is ligated both at the esophagus and the duodenum and the intestinal portion which is ligated at the duodenum

The inspection consists of palpating the lungs and their accompanying lymph glands, the heart, and the liver. The bile duct is cut transversely to permit examination for possible fluke infestation. The abdominal viscera are observed for any abnormal condition.

The rail inspector observes the carcass as it is hanging from the rail, head attached. He palpates the prescapular, prefemoral, and superficial inguinal (supramammary lymph glands). Using both hands, he then opens up the interior of the carcass to view, examining the surfaces of the peritoneum and pleura. He also examines the pelvic cavity to detect any contamination or portions of the genitalia which may have been left attached during the dressing operation. He looks at the head, particularly, to make sure that all of the skin and the horns have been removed.

When a condition is found which requires more detailed examination of the carcass, the organs or lymph glands related to the condition are examined further by repeated incisions and palpation. Carcasses and their viscera which require final inspection are taken to the space set apart for that purpose.

When the carcass passes the inspection it moves along the rail to the position where it is given a thorough washing. The head is removed. Each head is handled individually by first flushing out contents of the nasal and oral cavities. Many heads are shipped to the trade as whole heads after chilling. Others are processed by removing the tongue, the cheek meat, and the brain. The tonsils are removed from each tongue which is washed individually before being placed on a tray for chilling. The brains are examined for detection of parasitic infestation.

FIG. 11.—Rail inspection of a lamb carcass.

A considerable number of sheep pancreatic glands have been found to be infested with tapeworms. The parasite is also found in the bile duct. Inspection guards against the tapeworm infested material entering food channels.

The lungs, heart, liver, and spleen are classed as edible; the lungs and heart usually being sold intact. The omental fat (caul fat) is saved for rendering into edible fat.

The small intestines are pulled from the mesenteric fat. They are

stripped of their contents and passed through sliming machines which crush and squeeze the mucous lining from their lumen. These intestines then go to the casing department. The mesenteric fat is kept clean and free from contamination and is saved for rendering into edible fat.

**Pathology.**—Under this heading consideration is given to abnormal conditions affecting carcasses, their organs, and parts of carcasses, which have meat hygiene significance. Only a brief mention is made of the etiology and pathogenesis of each condition, since they are fully covered in courses and texts on veterinary bacteriology, pathology, and parasitology. The consideration given to lesions and their post-mortem significance is calculated to give only that emphasis which is necessary to relate the condition found on post-mortem inspection to the disposition of the affected carcass, organ, or part of carcass as to its fitness for human food.

**Tuberculosis.**—This is a chronic, infectious disease affecting man, animals, and poultry, showing occasional acute manifestations. In the United States, the program of eradication of tuberculosis from cattle has progressed

| *Item* | | *Cattle No.* | *%* | *Swine No.* | *%* |
|---|---|---|---|---|---|
| Animals slaughtered in | 1920 | 9,709,810 | | 38,981,914 | |
| | 1948 | 14,250,362 | | 48,551,552 | |
| Animals retained for tuberculosis in | 1920 | 200,647 | 2.05 | 4,360,719 | 11.16 |
| | 1948 | 15,422 | 0.18 | 2,968,631 | 6.11 |
| Animals condemned for tuberculosis in | 1920 | 37,492 | .386 | 65,607 | .168 |
| | 1948 | 1,461 | .010 | 9,761 | .020 |

**Fig. 12.—Retentions and condemnations of cattle and hogs under Federal Meat Inspection, years 1920 and 1948.**

successfully to that point where eradication is considered to be practically accomplished. The success of this program is dramatically illustrated by comparing the number of retentions and condemnations of cattle for tuberculosis under Federal meat inspection during the year 1920 with the year 1948 (Fig. 12). The eradication of tuberculosis from cattle has not resulted in a comparable lowering of the incidence of tuberculosis in swine. The higher percentage of swine affected with tuberculosis is explained by the transmissibility of avian tuberculosis to swine. There is a high incidence of tuberculosis in poultry in the United States.

Lesions of coccidioidal granuloma (see page 78) in cattle resemble lesions of tuberculosis. Hypothetically, histoplasmosis might be confused with tuberculosis, however, this condition has not so far been identified in meat inspection post-mortem examinations.

Davis *et al.* report 1 hog and 11 cattle with mucormycosis involving the mesenteric lymph nodes alone or thoracic lymph nodes and lungs. Grossly, these lesions strongly resembled lesions of tuberculosis.

*Etiology and Pathogenesis.*—*Mycobacterium tuberculosis*, bovine type, causes tuberculosis in cattle. *Mycobacterium avium* is the cause of tuberculosis in poultry. Both of these organisms are pathogenic for swine. Sheep are moderately susceptible to both organisms. The organism enters

the body through the respiratory and digestive tracts. In cattle, the respiratory tract and the pleura are most generally affected. However, involvement of the lymph glands of the digestive tract, the peritoneum, and the liver is quite common. The cervical, bronchial, and mediastinal lymph glands are the most common sites of infection in cattle. In addition, lesions of tuberculosis may occur in any of the organs and the visceral and body lymph glands.

In swine, the lesions most commonly occur in the cervical, bronchial, mediastinal, and mesenteric lymph glands. The involvement of the liver, spleen, and mesenteric lymph glands is more common in swine than in

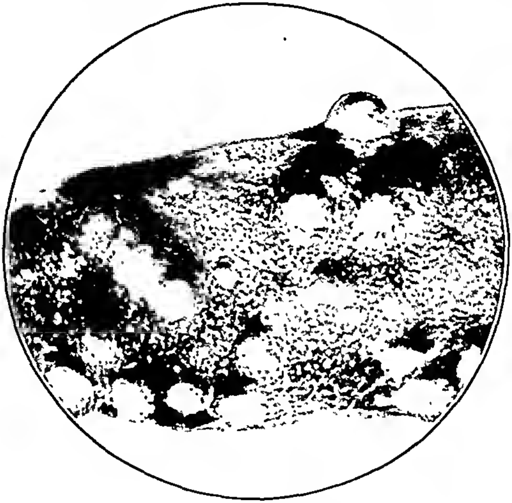

FIG. 13.—Lesions of tuberculosis in a hog spleen.

cattle. However, pulmonary involvement is quite common in swine. Lesions may occur also in any of the organs, the viscera, and the body lymph glands.

In sheep, the lesions are generally confined to the lymph glands of the respiratory tract and the lungs. In poultry, the disease is seen most frequently in the liver, spleen, intestines, and bone marrow. The infection in the majority of instances in poultry occurs by way of the digestive tract, resulting in a greater incidence of involvement in the organs of that tract rather than the lungs.

*Lesions.*—The tubercle is the characteristic lesion of tuberculosis. In the early stages, it is a gray, transparent nodule just large enough to be

seen by the unaided eye. As the lesion develops, caseous degeneration commences in the center which gives the tubercle a yellowish cast. Tubercles fuse to form nodules of increasing size. The nodules combine to form a large, yellow caseous mass which tends to calcify. The size of these masses varies considerably. The center of such a mass varies in consistency from caseo-purulent to caseous and caseo-calcareous. Histologically, lesions generally show central areas of caseation necrosis containing points of calcification surrounded by a zone of lymphocytes, epithelioid cells, fibroblasts and giant cells. Acid-fast Mycobacterium organisms are found in the lesions.

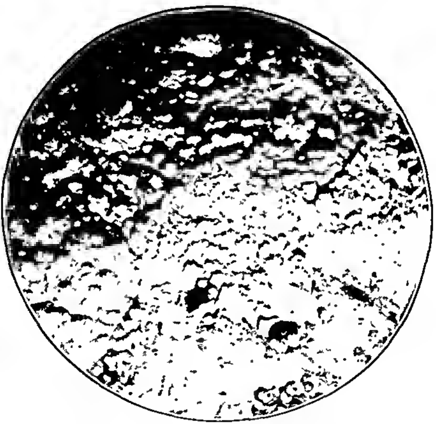

FIG. 14.—Lesions of tuberculosis affecting the peritoneum of a cow.

It is now well established that tuberculosis is essentially an affection of the reticulo-hystiocytic system. The tubercle bacillus, once introduced into the animal body, rapidly becomes localized in the reticulo-hystiocytic system. Present findings justify the conclusion that the infective power of the bacillus to attack muscle tissue is extremely low.

*Post-Mortem Significance.*—Tissue affected with tuberculosis or contaminated by the products of a tuberculous process is unfit for food. An organ is unfit for food when it contains a lesion of tuberculosis or a lesion of tuberculosis occurs in a lymph gland draining the organ. The head of the carcass is unfit for food when a well-marked lesion of tuberculosis occurs in a cervical lymph gland draining the head. A carcass, any part

thereof, and all of its viscera are condemned when an extensive involvement of tuberculosis occurs in either body cavity or when affected with the acute or miliary form of the disease. The following principles are declared for guidance in passing on carcasses affected with tuberculosis:

(*a*) No meat should be passed for food if it contains tubercle bacilli, or if there is a reasonable possibility that it may contain tubercle bacilli, or if it is impregnated with toxic substance of tuberculosis or associated septic infections.

(*b*) Meat should not be destroyed if the lesions are localized and not numerous, if there is no evidence of distribution of tubercle bacilli through the blood or by other means to the muscles or to parts that may be eaten with the muscles, and if the animal is well nourished and in good condition, since in this case there is no proof, or even reason to suspect, that the flesh is unwholesome.

(*c*) Evidences of generalized tuberculosis are to be sought in such distribution and number of tuberculous lesions as can be explained only upon the supposition of the entrance of tubercle bacilli in considerable number into the systemic circulation. Significant of such generalization is the presence of numerous uniformly distributed tubercles throughout both lungs, also tubercles in the spleen, kidneys, bones, joints, and sexual glands and in the lymph glands connected with these organs and parts, or in the splenic, renal, prescapular, popliteal, and inguinal glands, when several of these organs and parts are coincidentally affected.

(*d*) Localized tuberculosis is tuberculosis limited to a single or several parts or organs of the body without evidence of recent invasion of numerous bacilli into the systemic circulation.

The carcasses of animals affected with tuberculosis are disposed of as follows:

(*a*) The entire carcass is condemned if any of the following conditions occur:

(1) When it was observed before the animal was killed that it was suffering with fever.

(2) When there is a tuberculous or other cachexia.

(3) When the lesions of tuberculosis are generalized, as shown by their presence not only at the usual seats of primary infection but also in parts of the carcass or in the organs that may be reached by the bacilli of tuberculosis only when they are carried in the systemic circulation. Tuberculous lesions in any two of the following-mentioned organs are to be accepted as evidence of generalization when they occur in addition to local tuberculous lesions in the digestive or respiratory tracts, including the lymph glands connected therewith: spleen, kidney, uterus, udder, ovary, testicle, adrenal gland, and brain or spinal cord or their membranes. Numerous tubercles uniformly distributed throughout both lungs also afford evidence of generalization.

(4) When the lesions of tuberculosis are found in the muscles or intermuscular tissue or bones or joints, or in the body lymph glands as a result of draining the muscles, bones, or joints.

(5) When the lesions are extensive in one or both body cavities.

(6) When the lesions are multiple, acute, and actively progressive. (Evidence of active progress consists of signs of acute inflammation about the lesions, or liquefaction necrosis, or the presence of young tubercles.)

(*b*) An organ or a part of a carcass is condemned under any of the following conditions:

(1) When it contains lesions of tuberculosis.

(2) When the lesion is localized but immediately adjacent to the flesh as in the case of tuberculosis of the parietal pleura or peritoneum. In this case not only the membrane or part affected but also the adjacent thoracic or abdominal wall is to be condemned.

(3) When it has been contaminated by tuberculous material through contact with the floor or a soiled knife or otherwise.

(4) Heads showing lesions of tuberculosis are condemned, except that when a head is from a carcass passed for food or for cooking and the lesions are slight, or calcified, or encapsulated, and are confined to lymph glands in which not more than two glands are involved, the head may be passed for cooking at 170° F. for thirty minutes after the diseased tissues have been removed and condemned.

(5) An organ is condemned when the corresponding lymph gland is tuberculous.

(6) Intestines and mesenteries showing lesions of tuberculosis are condemned, except that when the lesions are slight and confined to the lymph glands and the carcass is passed without restriction, the intestines may be passed for use as casings and the fat passed for rendering after the corresponding lymph glands have been removed and condemned: *Provided,* That the fat and intestines have not been contaminated with tuberculous material.

(*c*) Carcasses showing lesions of tuberculosis should be passed for food when the lesions are slight, localized, and calcified or encapsulated, or are limited to a single or several parts or organs of the body (except as noted in paragraph (a) of this section), and there is no evidence of recent invasion of tubercle bacilli into the systemic circulation. Under this paragraph carcasses showing such lesions as the following examples may be passed, after the parts containing the lesions are removed and condemned in accordance with paragraph (*b*) of this section:

(1) In the cervical lymph glands and two groups of visceral lymph glands in a single body cavity, such as the cervical, bronchial, and mediastinal glands, or the cervical, hepatic, and mesenteric glands.

(2) In the cervical lymph glands and one group of visceral lymph glands and one organ in a single body cavity, such as the cervical and bronchial glands and lungs, or the cervical and hepatic glands and the liver.

(3) In two groups of visceral lymph glands and one organ in a single body cavity, such as the bronchial and mediastinal glands and the lungs, or the hepatic and mesenteric glands and the liver.

(4) In two groups of visceral lymph glands in the thoracic cavity and one group in the abdominal cavity, or in one group of visceral lymph glands in the thoracic cavity and two groups in the abdominal cavity, such as the bronchial, hepatic, and mesenteric glands.

(5) In the cervical lymph glands and one group of visceral lymph glands in each body cavity, such as the cervical, bronchial, and hepatic glands.

(6) In the cervical lymph glands and one group of visceral lymph glands in each body cavity, together with the liver when the latter contains but few localized foci. In this class of carcasses, which will be chiefly those of

hogs, the lesions of the liver are considered to be primary, as the disease is practically always of alimentary origin.

(*d*) Carcasses which reveal lesions more severe or more numerous than those described for carcasses to be passed (paragraph (*c*) of this section), but not so severe nor so numerous as the lesions described for carcasses to be rendered into lard, rendered pork fat, or tallow, or otherwise cooked at 170° F. for thirty minutes, if the distribution of the lesions is such that all parts containing tuberculous lesions can be removed.

**Actinomycosis.**—This is an infection of the mandible and maxilla occasionally encountered during the inspection of the head and cervical region of cattle. The condition is commonly referred to as "lumpy jaw."

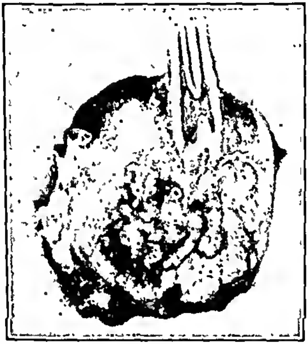

FIG. 15.—Actinomycosis affecting a bovine mandible (cross section).

*Etiology and Pathogenesis.*—The "ray fungus," *Actinomyces bovis* is the causative agent. The organism is thought to enter through the mucous membrane by way of injuries to the mucosa caused by rough forage. Lesions in the tongue, the soft tissues of the head, and in the viscera were once thought to be caused by this organism. These lesions are now considered to be caused by the *Actinobacillus lignieresi.* Lesions resembling actinomycosis in the udder are also attributed to the actinobacillus.

*Lesions.*—The lesions are limited to the bony structure of the head and are characterized by the formation of soft granulomatous tissue. Necrotic areas form which develop into abscesses. The abscesses break down to form sinuses or fistulus tracts. A characteristic pus is formed which is thick, tenacious, and greenish-yellow.

*Post-Mortem Significance.*—In those heads in which the enlargement is moderate and there is no discharge of pus from the process, the tongue is removed and passed for food while the head is unfit for food. In those cases where the involvement is large and pus is discharging from the process, the entire head including the tongue is unfit for food.

**Actinobacillosis.**—This condition is the one generally found involving the tongue and is known as "wooden tongue."

*Etiology and Pathogenesis.*—The organism *Actinobacillus lignieresi* is the infective agent. It is believed to pass into the body through injuries of the mucosa, being then picked up by the lymphatics. The usual sites of infection are the tongue and cervical lymph glands, and lesions also occur under the skin in the cervical region. Occasionally, the infection

Fig. 16.—Actinobacillosis tongue-bovine.

involves the bronchial and mediastinal lymph glands and the lungs. Lesions also occur in the udder; the infection is believed to gain entrance through the teats from the mouth of the suckling offspring.

*Lesions.*—At the site of infection a tumorous mass slowly develops. Later, softening of the interior of the mass occurs with the formation of a thick, mucoid pus. Lesions of actinobacillosis are frequently mistaken for actinomycosis. The distinguishing characteristic, however, is the fact that the actinomyces usually attacks the bone while the actinobacillus invades the soft tissues.

*Post-Mortem Significance.*—When the disease is slight and limited to the lymph glands of the head, the head including the tongue is fit for

food after removal of the affected glands. The head including the tongue is unfit for food where there is a more extensive involvement than the foregoing. When the involvement of the viscera or the udder is slight and localized, the carcass is fit for food provided the affected organs are disposed of as unfit for food. There is rarely an extensive involvement of the lung in which case the entire carcass is unfit for food.

**Cysticercosis.**—*Cysticercosis in Cattle.*—This is the condition known as "beef measles" commonly occurring in cattle but only occasionally in calves.

*Etiology and Pathogenesis.*—The bladder worm, cysticercus bovis, is the cystic form of the adult tapeworm, *Tænia saginata,* occurring in man.

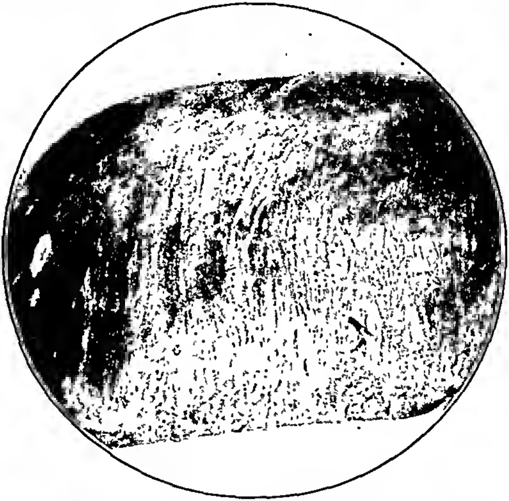

FIG. 17.—Section of muscle of bovine heart showing degenerated cysts of *Cysticercus bovis.*

The cyst is found chiefly in the muscles of the jaw, heart, and diaphragm, and also in the musculature in many other parts of the body. In some cases the wall of the esophagus is the preferred location.

*Lesions.*—The full-grown bladder worm measures about 7½ by 5½ mm. situated in the intra-muscular connective tissue surrounded by a thin connective tissue capsule. The cysticerci may die a short time after development and become calcified.

*Post-Mortem Significance.*—A carcass in which only one dead and degenerated cyst is found on inspection is passed for food without restriction

after removal of the cyst. A carcass showing a slight or moderate infection as determined by a careful examination of the heart, muscles of mastication, the diaphragm and its pillars, the tongue, and all of the portions of the carcass rendered visible by the process of dressing, is passed for food after removal of the cysts and after the carcass and all of its parts have been held in a temperature of not higher than 15°F. continuously for a period of not less than ten days. A carcass showing an extensive infestation is unfit for food.

CYSTICERCOSIS IN SWINE.—This is the condition known as "pork measles."

FIG. 18.—Cysticercus cellulosæ in a hog heart.

*Etiology and Pathogenesis.*—The bladder worm known as *Cysticercus cellulosæ*, the cystic form of *Tænia solium* occurring in man, produces this condition. The cysts are found chiefly in the muscles of the heart, tongue, thigh, and neck. They may also invade the fat and other tissues. The carcass affected with this condition when opened at the neck for cervical inspection will often show the cysts distributed in the tissue under the tongue like a bunch of grapes.

*Lesions.*—The fully developed cyst measures up to 20 by 10 mm. and contains an invaginated scolex which resembles that of the adult worm. Although the larvæ continue alive for a long time, degenerated cysts are seen in which the scolex is all that remains.

*Post-Mortem Significance.*—A carcass affected with this condition is unfit for food.

CYSTICERCOSIS IN SHEEP.—(*A*) CYSTICERCUS OVIS.—This condition in sheep is similar to the cysticercosis which occurs in cattle. Although the involvement is comparable to the condition known as cattle measles and hog measles, the term "sheep measles" has not come into general use.

*Etiology and Pathogenesis.*—The causative agent is the *Cysticercus ovis* which is the cystic form of *Tænia ovis* occurring in the small intestine of the dog. The cysts are usually seen in the heart, diaphragm, and the tongue. Although the cysts are reported as occurring in other tissues they are usually observed confined to the musculature.

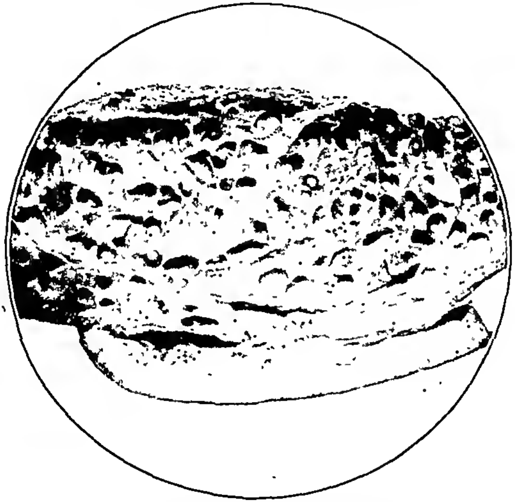

FIG. 19.—Section of hog muscle showing cysticercus cellulosæ infestation.

*Lesions.*—The cyst resembles *Cysticercus bovis* in size and consistency. Usually the larvæ die after a short time and the lesions become organized with a degree of calcification.

*Post-Mortem Significance.*—Carcasses so affected that complete removal of the cysts cannot be accomplished with certainty are not fit for food. Where the infestation is slight and all of the cysts can be removed, the carcass is passed for food.

(*B*) CYSTICERCUS TENUICOLLIS.—This condition in sheep is distinguished from other cysticercus involvement in that the cysts occur pendulous in the peritoneal cavity. It does not infest the musculature.

*Etiology and Pathogenesis.*—The cyst is caused hy the *Cysticercus tenuicollis*, the cystic form of the *Tænia hydatigena* which occurs in the dog and other carnivora. The cysticerci break down the liver parenchyma during their migration, causing hemorrhages and leaving hehind them a tract of detritus. The cysts are seen hanging free in the peritoneal cavity attached to the peritoneum. Foci of bronchopneumonia and pleuritis have heen descrihed as heing caused by young cysticerci which enter the lungs.

*Post-Mortem Significance.*—Generally, the condition is found to he limited to the presence of cysts in the peritoneal cavity. In such cases the cysts can he readily removed and the carcass is then fit for food. Should the involvement he such as to affect the general condition of the carcass, it is unfit for food.

Fig. 20.—Cysticercus tenuicollis omentum of sheep.

**"Gid" in Sheep.**—This condition is caused by parasitic invasion of the brain and spinal cord generally observed in meat inspection only in sheep but reported to occur also in other domesticated animals and in man.

*Etiology and Pathogenesis.*—The causative agent is the *Multiceps multiceps* (*Cœnurus cerebralis*) which is the intermediate stage of the *Tænia multiceps* which occurs in the small intestine of the dog. Usually the cyst is situated on the surface of one of the cerehral hemispheres. Cysts do occur, however, in any part of the brain. Occasionally, the cyst is located in the spinal cord. The condition usually seen in post-mortem meat inspection is the brain involvement.

*Lesions.*—The full-grown cyst measures 5 cm. or more in diameter. It has a delicate, translucent wall and bears on its inner surface a number

of heads which may amount to several hundred, each resembling the scolex of the adult worm.

*Post-Mortem Significance.*—This condition is not frequently seen in meat inspection since animals having any degree of involvement would not reach the slaughtering department. The condition seen on post-mortem consists of a slight involvement of the brain with the carcass showing no systemic change. In such cases the brain is unfit for food while the carcass is passed for food. Should the carcass show any systemic involvement as a result of the cystic condition, it is unfit for food.

**Stomach Worm in Sheep.**—This condition is also known as "wire worm" and affects all ruminants. The sheep involvement is the only one of significance in meat inspection.

*Etiology and Pathogenesis.*—The condition is caused by the nematode *Hæmonchus contortus*, the male measuring 10 to 20 mm. long, the female 18 to 30 mm. The male has an even reddish color while in the female the white ovaries are slightly wound around the red intestine. Upon entering the host, the young worms burrow into the mucosa of the abomasum. The adult worms live free in the abomasum and attack the mucosa which they pierce with their buccal lancets to suck blood. It appears likely that an anti-coagulant is inserted into the wound by the parasite. The mucosa becomes very irritated and the worms deprive the host of a large quantity of blood. It is probable that a large amount of blood also passes through the body of the parasite.

*Lesions.*—The irritation of the abomasum is secondary in importance to the loss of blood. Anemia develops with a degree of rapidity depending on the extent of the infestation. In lambs or young sheep with severe infestation, anemia develops rapidly.

*Post-Mortem Significance.*—Animals in which the condition has not developed to the point where ante-mortem symptoms are noticed are passed on post-mortem inspection as being fit for food. The abomasum is not an article of human food in any case and is handled as inedible. Carcasses from animals which have been suspected on ante-mortem inspection of being affected with a condition which might cause their condemnation on post-mortem inspection are unfit for food when affected with anemia resulting from infestation by this parasite.

**"Ox Warbles".**—This condition is a common parasite of cattle and calves and is widespread in the United States.

*Etiology and Pathogenesis.*—The condition is caused by the larvæ of the heel flies, *Hypoderma lineatum* and *Hypoderma bovis*. The larvæ hatch from the eggs which are laid on the hair of the skin and crawl down the hair to the skin through which they penetrate. They wander in the subcutaneous connective tissue gradually finding their way to the esophageal wall where they lie in the submucous connective tissue for the rest of the summer and autumn growing to about 12 mm. in length. In the latter part of the winter the larvæ migrate to the subcutaneous tissue of the back. Here they increase in size to about 3 cm.

*Lesions.*—The nodules caused by the larvæ in the subcutaneous tissue of the esophagus usually contain small amounts of pus. At the sites of the larvæ in the subcutaneous tissue of the back a definite localized swelling

occurs surrounded by some edema. Along with the larva the swelling includes considerable pus and takes on the appearance of a small abscess.

*Post-Mortem Significance.*—The mucous lining of the esophagus is one of the animal casings and the presence of the larvæ makes the casing unfit for use as a container of human food. The involvement of the subcutaneous tissue of the back by the larvæ is generally localized. Complete removal of the tissue involved with the parasitic process is usually sufficient to permit passing the carcass for food. The back of older calves dressed with the skin on is palpated to detect swellings caused by the parasite. When present, the skin is required to be removed from the carcass and the affected tissue removed by trimming.

**Kidney Worm of Swine.**—This parasite is widely distributed in the Southern part of the United States and in the East Central States and is of considerable economic importance because of the large amount of tissue which is required to be trimmed away from swine carcasses due to the infestation.

*Etiology and Pathogenesis.*—The condition is caused by the round worm *Stephanurus dentatus.* The male is 20 to 30 mm. long, the female 30 to 45 mm. long. The development of the parasite in the host is somewhat complicated. Suffice it to say the migration of the larvæ causes damage to the liver. The principal involvement, however, affects the sublumbar region where the parasites invade the perirenal tissues. They penetrate into the organs of that region, and the psoas muscles, fanning out to involve all tissues in their path depending upon the degree of infestation.

*Lesions.*—The sublumbar region of all swine carcasses must be examined carefully to detect the probable presence of this parasite. In light infestations, there are few evidences of the parasite's presence. Slight edema frequently occurs and the perirenal fat shows a slight hyperemia as evidence of the parasite. It is necessary sometimes to cut into the tissue to reveal the lesions. Where the infestation is extensive the tissue changes are more marked, there being extensive edema and some hemorrhage.

*Post-Mortem Significance.*—Carcasses affected with this condition when extensive and accompanied with systemic manifestations are unfit for food. Carcasses are passed for food when the infestation is slight and complete removal of the parasites and involved tissue can be accomplished.

**"Nodular Disease" in Sheep.**—This condition which is limited to sheep and goats is of significance principally because it destroys a large number of intestines for use as animal casings.

*Etiology and Pathogenesis.*—The condition is caused by the larval form of the round worm *Oesophagostomum columbianum.* The larvæ pierce the wall of the intestine in which they grow to a length of about 1.5 to 2.5 mm.

*Lesions.*—The reaction of the tissue of the wall of the intestine to the presence of the larvæ forms the characteristic nodules which vary in size up to 5 mm. The contents of these nodules caseate and calcify. There is usually an opening from the nodule into the intestine.

*Post-Mortem Significance.*—The condition as it is usually seen in meat inspection does not affect the disposition of the carcass even though the intestines are involved to a considerable extent by the parasite. The

carcass is passed for food after elimination of the affected intestines provided there is no systemic involvement. Where the parasitic condition is such as to produce peritonitis associated with systemic manifestations, the carcass is unfit for food.

**Hydatid Disease.**—This condition affects man as well as domesticated mammals. There has been a gradual decrease in the occurrence of this condition in the United States. It is only rarely seen during the conduct of meat inspection post-mortem examinations.

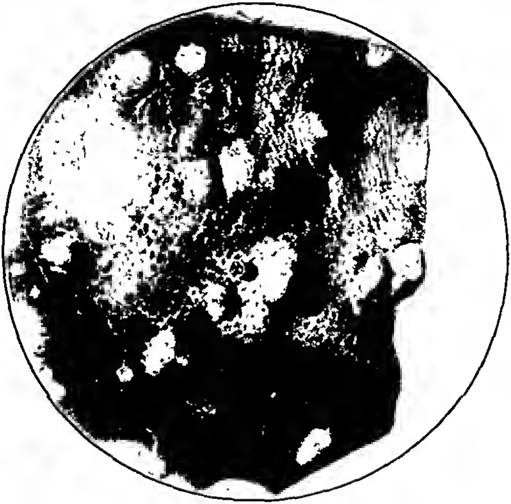

Fig. 21.—Echinococcus cysts in a hog liver.

*Etiology and Pathogenesis.*—The condition is caused by the embryonic stage of the tapeworm *Echinococcus granulosus* which is found in the small intestine of carnivora. The eggs are ingested by the intermediate host, hatching in the intestine. The embryos then migrate through the bloodstream to the various organs of the host. They usually locate in the liver and lungs.

*Lesions.*—The embryo forms in a large vesicle 5 to 10 cm. in diameter. A thick cuticle forms around the vesicle concentrically laminated with an internal germinal layer. The vesicle is filled with a clear, colorless fluid. Daughter cysts are sometimes formed.

*Post-Mortem Significance.*—Affected organs are unfit for food.

**Pentastoma.**—This condition affects herbivorous animals. It is most commonly seen in cattle on meat inspection post-mortem examinations.

*Etiology and Pathogenesis.*—The condition is caused by the nymphal stage of the *Linguatula serrata*, the "Tongue-worm" which occurs in the nasal and respiratory tract of carnivora principally. The eggs which are expelled from the respiratory tract of the host hatch in the alimentary canal of the intermediate herbivorous host. The larvæ reach the mesenteric lymph glands where they develop into the infective nymphal stage. The nymph is 5 to 6 mm. long and has a white color.

*Lesions.*—The nympha are present in the mesenteric lymph glands in small cysts surrounded by a viscid turbid fluid. The presence of the cysts results in an enlargement of the affected lymph glands and gives them a juicy consistency. In older lesions there is a tendency towards caseation producing a lesion which is sometimes confused with tuberculosis.

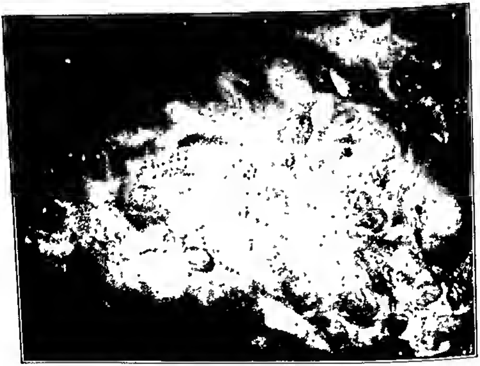

FIG. 22.—Echinococcus cysts—lung of a ewe.

*Post-Mortem Significance.*—The condition is localized in the mesenteric lymph glands. Accordingly, the carcass is passed for food after the mesenteric fat with the imbedded lymph glands is disposed of as being unfit for food.

**Onchocerca Gibsoni.**—The condition caused by this round worm was once thought to occur only in cattle imported into this country from Australia. In recent years the condition has been reported in connection with meat inspection post-mortem examinations made in the United States.

*Etiology and Pathogenesis.*—The male *Onchocerca gibsoni* is 30 to 53 mm. long and the female has been reported as measuring 500 mm. or more. The vector of this parasite is not definitely known. The parasite first wanders about in the connective tissue before coming to rest usually in the region of the brisket and the external surfaces of the hind limbs.

*Lesions.*—At these locations they form "worm nests" which are surrounded by a fibrous connective tissue capsule which increases in size as the lesion grows older. The whole nodule may be 5 cm. in diameter. It is ovoid or flattened in shape. The worm nest consists of tunnels containing the coiled worm. In older nodules degeneration of the tissues and calcification of the worms frequently occurs.

*Post-Mortem Significance.*—The condition is localized and the carcass is passed for food after the affected tissue is removed.

**Ascariasis.**—The worms causing this condition in man and in swine are morphologically indistinguishable. It is a common round worm infection of swine associated with unclean housing conditions.

Fig. 23.—Obstructive jaundice—obstruction of bile duct by ascarids—hog liver.

*Etiology and Pathogenesis.*—The condition is caused by the *Ascaris lumbricoides*, the male measuring 15 to 25 cm. by about 3 mm., and the female up to 41 cm. by 5 mm. The ingested eggs hatch in the intestine and the larvæ burrow into its wall. The larvæ pass through into the peritoneal cavity reaching the liver either by migration direct or through the bloodstream. From here they are carried by the blood to the lungs where they are arrested in the capillaries.

*Lesions.*—The larvæ cause much damage in the liver and lungs during their migration. They produce hemorrhage and destroy tissue in the liver. In the lungs, they cause numerous hemorrhages into the alveoli and bronchioles. Secondary bacterial invasion of the lung lesions sometimes results in pneumonia. The adult parasite in the intestines does considerable damage to the walls of the intestines, however, the principal damage here

is caused by their wandering up the bile duct into the liver. This occasionally produces icterus in the carcass due to the stoppage of the bile duct.

*Post-Mortem Significance.*—Carcasses showing icterus as a result of the infestation are unfit for food. Carcasses showing systemic manifestations in connection with inflammatory lung processes caused by the infestation are unfit for food. Localized conditions in the lungs are of little significance inasmuch as the lungs of swine are always handled as inedible. Livers affected by the infestation are fit for food only if the damage is so slight as to permit removal of the damaged tissue from the unaffected portion of the liver.

Liver Flukes.—DICROCOELIUM DENDRITICUM. This is the smallest of the three liver flukes affecting domesticated animals. It is most commonly seen in cattle and sheep and occasionally in swine.

*Etiology and Pathogenesis.*—This fluke is from 6 to 10 mm. long and from 1.5 to 2.5 mm. wide. The body is elongated, narrow anteriorly and widest behind the middle. These small flukes invade the small branches of the bile ducts in which they lie greatly extended and attached by their suckers. Occasionally they occur along with the *Fasciola hepatica* (*infra*).

*Lesions.*—No marked change is produced in the liver unless the infestation is heavy. Cirrhosis of the liver occurs in heavy infestation as well as other indurative changes of the liver tissue.

*Post-Mortem Significance.*—Affected livers are unfit for food regardless of the degree of infestation.

FASCIOLA HEPATICA.—This fluke usually infests ruminants, rarely affecting swine and man. It causes the condition usually referred to as "liver rot" in sheep and cattle.

*Etiology and Pathogenesis.*—The fluke reaches 30 by 13 mm. in size, is leaf-shaped, and is broader anteriorly than posteriorly. It has an anterior cone-shaped projection which is followed posteriorly by a pair of "broad shoulders." The young fluke burrows into the intestinal wall reaching the liver generally by way of the blood stream. Others migrate through the peritoneal cavity entering the liver by penetrating its capsule. They attach themselves to the peritoneum occasionally along the way to suck blood. After entering the liver they grow and wander in the liver tissue eventually reaching the bile ducts.

*Lesions.*—No significant damage is done in the peritoneal cavity. The young flukes destroy the liver tissue as they wander through it, the destruction increasing as the parasite grows. The adult flukes in the bile duct cause considerable irritation of the mucosa resulting in chronic cholangitis and cirrhosis which extends into the liver tissue. Icterus sometimes occurs in the carcass due to stasis of bile as the result of large flukes blocking the ducts.

*Post-Mortem Significance.*—Carcasses affected with icterus due to fluke infestation are unfit for food. Affected livers, regardless of degree of infestation, are unfit for food.

FASCIOLOIDES MAGNA.—This is the largest of the flukes infesting the livers of cattle and sheep. It is reported to occur rarely in the lungs. This parasite is not encountered in meat inspection post-mortems as frequently as the other two flukes.

*Etiology and Pathogenesis.*—The fluke is quite large, measuring up to 100 by 25 mm. A characteristic that assists in distinguishing this fluke from *Fasciola hepatica* is the absence of an anterior cone-like projection which is present on the smaller parasite. The parasite wanders about in the liver tissue becoming encapsulated eventually. Their pathogenicity in cattle is reported as being relatively low since the young parasites become encapsulated before reaching maturity. In sheep the parasite reaches maturity unchecked doing great damage in the liver.

*Lesions.*—Due to the amount of damage done to the liver tissue and the tendency toward encapsulation of the parasite, infested livers present an uneven surface appearance. There is also a characteristic black pigmentation of the liver and the hepatic glands extending sometimes to the adjacent peritoneum.

*Post-Mortem Significance.*—Affected livers are unfit for food regardless of the extent of the infestation.

**Mange.**—SARCOPTIC.—This condition commonly affects all domesticated animals.

*Etiology and Pathogenesis.*—The sarcoptes mange mite is a very small parasite roughly circular in outline. It prefers those parts of the body that are not covered by much hair or wool. The parasite pierces the skin to feed on the lymph and young epithelial cells.

*Lesions.*—The irritation and inflammation of the skin results in an exudate which forms a crust over the surface. As the condition progresses there is extensive keratinization and proliferation of the subcutis. This is usually accompanied with the loss of hair.

*Post-Mortem Significance.*—Where the condition is associated with emaciation in the animal, the carcass is unfit for food. Generally, the condition is limited to the skin and has no noticeable effect on the well-being of the host. In sheep and cattle where the hide is removed as part of the dressing operation, the condition has no post-mortem significance when localized in the skin. All affected hides are removed from calves after which the carcass is passed for food. Affected portions of the skin are removed from hog carcasses which are then passed for food.

PSOROPTIC.—This type of mange does not affect swine but is found in sheep and cattle. However, by contrast with sarcoptic mange, this condition is caused by a number of different parasites, each specific for different species of host.

*Etiology and Pathogenesis.*—The condition in sheep is caused by the *Psoroptes communis ovis* and in cattle by the *Psoroptes communis bovis.* The mites are oval in shape. They prefer those parts of the body that are well-covered with hair or wool. They puncture the epidermis to feed on the lymph, thereby setting up an inflammation characterized by a swelling infiltrated with serum. This results in an exudation on the surface of the affected part which coagulates to form a crust. The mites are particularly active along the borders of the affected area thereby extending the process.

*Lesions.*—The lesions occur principally around the shoulders, sides, and back. These areas become matted to form the characteristic scab.

*Post-Mortem Significance.*—In those cases where emaciation or systemic

involvement accompany the mange, the carcass is unfit for food. Otherwise the carcass is passed for food.

DEMODECTIC.—This is the third type of mange and affects all domesticated animals. It is frequently referred to as follicular mange. It is not as common as the other two.

*Etiology and Pathogenesis.*—The demodex mange mites are very tiny. They are elongated by contrast with the sarcoptes mange mite which is circular in outline and the oval psoroptes. The parasite is approximately 0.25 mm. long. The mites develop in the skin of the host entering the hair follicles and sebaceous glands.

*Lesions.*—The chronic inflammation produced by the parasite causes proliferation and thickening of the epidermis with the loss of hair. Pustules and abscesses frequently form in the hair follicles and sebaceous glands due to a secondary bacterial invasion. The formation of pustules and abscesses associated with demodectic mange helps to distinguish it from the other forms of mange.

*Post-Mortem Significance.*—The carcass is unfit for food when the infestation has progressed to the point where the carcass shows evidence of toxemia or emaciation. Generally, the condition has not progressed so far as to affect the carcass, in which case it is passed for food after removal of the diseased tissue.

**Lung Worms.**—CATTLE.—This condition is usually seen in young animals only.

*Etiology and Pathogenesis.*—The *Dictyocaulus viviparus* is the cause of the condition. The male measures $4\frac{1}{2}$ to 5 cm. long, the female 6 to 8 cm. long. They infest the bronchi.

*Lesions.*—In the young animal the presence of the parasites in the bronchi sets up varying degrees of inflammation in the lungs. In advanced cases emaciation and anemia are observed.

*Post-Mortem Significance.*—The carcass is fit for food when the infestation is slight and there is no secondary change, provided the lungs are eliminated as unfit for food. In those cases where there is pneumonia accompanied with systemic manifestations or when there is emaciation or anemia the carcass is unfit for food.

SWINE.—There are three round worms which commonly infest the lungs in swine.

*Etiology and Pathogenesis.*—They are *Metastrongylus apri*, male up to 25 mm. long, female up to 58 mm. long; *Metastrongylus pudendotectus*, male up to 18 mm. long, female up to 37 mm. long; and *Metastrongylus salmi*. They infest the bronchi and bronchioles.

*Lesions.*—The parasites set up varying degrees of inflammation in the lungs producing a verminous bronchitis and sometimes pneumonia. The parasites sometimes die in the small bronchioles with resulting nodule formation. These nodules may be confused with tuberculous nodules in meat inspection post-mortem examination.

*Post-Mortem Significance.*—Generally, the condition is localized in the lungs in which case the carcass is passed for food; hog lungs in any case are handled as inedible. Where there is extensive inflammation of the lung associated with systemic change, the carcass is unfit for food.

SHEEP.—There are also three lung worms affecting sheep. Two of them are found in the bronchi and bronchioles while the third invades the parenchyma of the lungs.

*Etiology and Pathogenesis.*—The *Muellerius capillaris*, male 12 to 14 mm. long, female 19 to 20 mm. long, invades the alveoli and the pulmonary parenchyma especially in the subpleural tissue. *Protostrongylus rufescens*, male 16 to 18 mm. long, female 25 to 35 mm. long, and *Dictyocaulus filaria*, male 3 to 8 cm. long, female 5 to 10 cm. long, invade the bronchi and bronchioles where they suck blood and irritate the mucosa.

*Lesions.*—The parasite which invades the lung tissue produces grayish nodules up to 2 cm. in diameter which tend to calcify. Those parasites which infest the bronchi and bronchioles set up inflammation varying in degrees and sometimes produce pneumonia.

*Post-Mortem Significance.*—All affected lungs are unfit for food and if the condition is localized in the lungs, the carcass is passed for food. The carcass is unfit for food when the inflammatory process in the lungs is associated with systemic changes.

**Tongue Worm.**—This condition is found principally in the tongues of swine, however, the parasite is sometimes found in the tongues of sheep. It also occurs in the esophagus of cattle, swine, and sheep.

*Etiology and Pathogenesis.*—The condition is caused by the *Gongylonema pulchrum*. The male measures up to 6.2 cm. long, while the female may be 14.5 cm. long. The worm is imbedded in a zig-zag or spiral fashion in the mucosa or submucosa.

*Lesions.*—There are no noticeable lesions since the presence of the worm does not appear to set up any inflammatory change. The presence of the parasite in the tongue can be detected by combing its mucous surface vigorously with a sharp object.

*Post-Mortem Significance.*—There is no case reported where this condition has affected the disposition of a carcass. It is a localized, non-inflammatory involvement. The affected tongues may be passed for food after removal of the mucosa. This can be accomplished by scalding the tongues thoroughly at a temperature of 145°F. or higher. The scalded tongues are then drenched with cold water after which the mucosa is readily removed. The mucous linings of the esophagus of swine and sheep are not used as edible products. The mucous lining of the esophagus of cattle is saved and processed as one of the animal casings. Since the parasite produces no inflammatory change in the mucosa, the casing is permitted to be used as a container for food.

**Sarcosporidiosis.**—This condition affects the musculature of all domesticated animals and is caused by a fungus.

*Etiology and Pathogenesis.*—The *Sarcocystis miescheriana* is usually given as the causative agent although some attempt has been made to identify a different species with each type of animal affected. The sarcocysts occur in muscle tissue anywhere in the body including the heart.

*Lesions.*—The sarcocyst varies in size from 25 microns to more than 1 cm. in length. As they become large enough to be seen with the naked eye, they appear threadlike and spindle-shaped, lined up in the same direction as the muscle fibers. They vary in color from white to yellow-brown.

*Post-Mortem Significonce.*—A carcass is unfit for food when the involvement is such as to not permit the complete elimination of the affected muscle tissue. When the condition is slight, the carcass is passed for food after elimination of all affected tissue.

**Coccidioidal Granuloma.**—This condition is sometimes confused with tuberculosis and actinobacillosis. It occurs principally in the far western part of the United States, however, cases have been identified in the midwest. It is of some importance as a human disease in the valleys of central and southern California.

*Etiology and Pathogenesis.*—The *Ascomycete coccidioides immitis* is the causative agent. Little is known of the method of contracting the disease or its transmissibility. The organism is known to occur in the soil and it is thought that the condition is contracted by inhaling the organism with particles of dust. The organism infects the internal organs, principally the lungs and their lymph glands.

*Lesions.*—Granulomatous processes develop in the lung and its lymph glands resembling tuberculosis and actinobacillosis, principally the latter. Histologically, the lesions are characterized by the occurrence of the spherules of the causative agent in a field of granulation tissue showing occasional giant cells.

*Post-Mortem Significance.*—Generally, the involvement is slight being localized in the lymph glands. In such cases the carcass is passed for food after eliminating affected organs and glands. A carcass is unfit for food when there is an extensive involvement of the lungs.

**Caseous Lymphadenitis.**—This condition is observed only in sheep and goats on meat inspection post-mortem examinations. It is reported as also occurring in cattle in the form of suppurative lymphadenitis.

*Etiology ond Pathogenesis.*—*Corynebacterium pseudotuberculosis* is the causative organism. The disease principally affects the lymph glands both visceral and body. It also occurs commonly in the lungs. The infection is believed to gain entrance through the skin by way of wounds, such as those caused by shearing, docking, and castration.

*Lesions.*—Abscesses develop at the site of involvement causing marked enlargement of the affected lymph glands. The pus is greenish-yellow tending to become dry and granular. There is little tendency for the lesions tn calcify.

*Post-Mortem Significance.*—The condition is usually slight and localized in a few lymph glands. In such cases the carcass is fit for food after removal of the affected tissue.

(*a*) A thin carcass showing well-marked lesions in the viscera and the skeletal lymph glands or such a carcass showing extensive lesions in any part is condemned.

(*b*) A thin carcass showing well-marked lesions in the viscera with only slight lesions elsewhere or showing well-marked lesions in the skeletal lymph glands with only slight lesions elsewhere may be passed for cooking.

(*c*) A thin carcass showing only slight lesions in the skeletal lymph glands and in the viscera may be passed without restriction.

(*d*) A well-nourished carcass showing well-marked lesions in the viscera and with only slight lesions elsewhere or showing well-marked lesions con-

fined to the skeletal lymph glands with only slight lesions elsewhere may be passed without restriction.

(*e*) A well-nourished carcass showing well-marked lesions in the viscera and the skeletal lymph glands may be passed for cooking at 170° F. for thirty minutes; but where the lesions in a well-nourished carcass are both numerous and extensive, it is condemned.

(*f*) All affected organs and glands of carcasses passed without restriction or passed for cooking are removed and condemned. The term "thin" as used in this section shall not be held applicable to a carcass which is anemic or emaciated.

Fig. 21.—Caseous lymphadenitis, spleen sheep.

**Anthrax.**—Every effort is made to eliminate on ante-mortem inspection all animals showing any sign of anthrax, not only because such animals are unfit for slaughter for food but it is imperative that the infection with the anthrax organism be kept out of the slaughtering department. Occasionally, cases of anthrax are missed on ante-mortem inspection, particularly those involving the cervical region of swine.

*Etiology and Pathogenesis.*—The condition is caused by *Bacillus anthracis.* Ruminants are particularly susceptible. In this species, the condition takes the form of a rapidly progressive blood-stream infection. It fre-

quently runs a fatal course in man. Swine are less susceptible, the condition showing a tendency to localize in the cervical region.

*Lesions.*—In cattle and sheep where the disease runs a septicemic course, hemorrhages occur in various parts of the body, the blood is dark, tarry, and does not clot, the spleen is markedly swollen and is dark red and soft, and there is a characteristic edematous infiltration of the subcutis. In swine where the disease tends to localize in the cervical region, the lymph glands are considerably swollen and hemorrhagic, occasionally there is extensive swelling and hemorrhage in the cervical region accompanied with acute pharyngitis. The lymph glands have a characteristic brick or salmon red color.

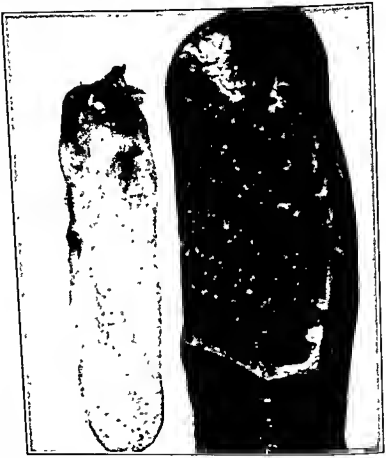

FIG. 25.—Anaplasmosis, bovine, affected spleen (right) normal spleen (left)

*Post-Mortem Significance.*—Carcasses affected with anthrax are unfit for food. When a carcass is found in the slaughtering department to be affected with anthrax, it is not handled any further on the dressing line but is disposed of immediately. There is prompt disinfection of the area and all equipment which were exposed to the affected carcass during its handling up to the point of condemnation. If a hog carcass is involved, the scalding vat water is immediately drained into the sewer and all parts of the vat are cleaned and disinfected. An effective disinfectant is a

5 per cent solution of sodium hydroxide or commercial lye containing at least 94 per cent of sodium hydroxide. The solution is applied as nearly scalding hot as possible. Every precaution is taken to protect the operator from being burned by this strong caustic solution.

Persons who have handled anthrax-contaminated material immediately cleanse their hands and arms with soap and running hot water. This process of cleansing is most effective when performed by repeated lathering and rinsing. After thorough cleansing, the hands and arms are immersed for about one minute in a 1 to 1000 solution of bichloride of mercury, followed by thorough rinsing.

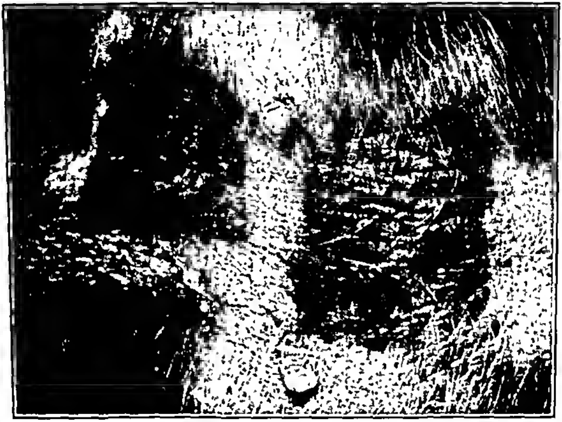

FIG. 26.—Urticarial lesions typical of "diamond skin disease."

**Anaplasmosis.**—Early workers on piroplasmosis or Texas fever of cattle considered the condition now known as anaplasmosis to be a stage in the development of piroplasmosis. The two conditions are entirely different and are caused by different organisms. Anaplasmosis is prevalent in most of the southern States of the United States and it has been reported in some of the northern States.

*Etiology and Pathogenesis.*—The condition is caused by the sporozoa *anaplasma marginale*. The life history of this parasite is unknown. It only affects cattle and it occurs principally in older animals in which it may run an acute or chronic course. It is a disease of the red blood corpuscles, the sporozoa enter the corpuscles to which they are parasitic.

*Lesions.*—The condition as it is seen on meat inspection post-mortem examination is evidenced by a progressive anemia and icteric appearance of the carcass. The spleen is usually quite swollen and friable in consistency.

Diagnosis is conclusive upon finding the characteristic marginal bodies in the red blood cells.

*Post-Mortem Significonce.*—Carcasses affected with this condition are unfit for food.

**Swine Erysipelas.**—This condition has become quite prevalent in the United States, particularly in the Corn Belt where it has developed into one of the major problems of the livestock industry. It is sometimes called "diamond skin disease." The skin condition, however, does not characterize all forms of the disease.

*Etiology ond Pathogenesis.*—The condition is caused by *Erysipelothrix rhusiopathiæ*. It is believed to infect swine through the digestive tract. Several forms of the disease are manifested: the septicemic type which is the acute form, the chronic form characterized by endocarditis and arthritis, and the form manifesting principally skin lesions from which the "diamond skin disease" term originated.

*Lesions.*—Accompanying the septicemic form of the disease are hemorrhagic gastroenteritis, marked enlargement of the spleen, swollen and hemorrhagic lymph glands, and petechial hemorrhages on the serous surfaces of organs. There also may be hemorrhages along the ventral portions of the carcass and the lungs may be congested. Also, an icteric condition may develop, usually associated with edematous areas under the serous membranes.

The endocarditis associated with the chronic form is characterized by a vegetative growth on the endocardium. The arthritis produces marked swelling of the affected joints.

The skin form of the disease is urticarial in nature and may be associated with lesions involving the viscera. As the skin form develops, the urticarial areas usually become necrotic with scab formation; these peel, and raw, sore areas develop.

*Post-Mortem Significonce.*—Carcasses affected with the septicemic form of the disease or the chronic or skin form associated with systemic involvement are unfit for food. In those carcasses where the condition has run its course and has become localized in the skin or arthritic joints, the carcass is passed for food after removal of the affected tissue or part.

**Hog Cholera.**—This is a highly infectious disease of swine characterized by high temperature and rapidly progressive septicemic involvement.

*Etiology and Pathogenesis.*—The condition is caused by a filterable virus. The virus is thought to gain entrance to the body from contaminated feed and water. The virus produces a blood-stream infection producing septicemic changes as the condition progresses.

*Lesions.*—There are small hemorrhages beneath the capsule of the kidneys, in the mucosa of the urinary bladder, and in the mucosa of the larynx and trachea. Small hemorrhages also sometimes occur in the intestinal mucosa and in the lymph glands, spleen, epicardium, and lungs. The kidneys present a typical appearance referred to as "turkey egg" which has been considered characteristic of the condition. Secondary infection sometimes invades the lung tissue to cause pneumonia, and the digestive tract to cause ulcerative enteritis.

*Post-Mortem Significance.*—Carcasses affected with hog cholera are unfit for food.

**Paratuberculosis.**—This condition is also called Johne's disease and affects cattle principally. It is reported as also affecting sheep but has not been reported on meat inspection post-mortem examinations.

*Etiology and Pathogenesis.*—The condition is caused by *Mycobacterium paratuberculosis.* The infection involves the intestinal canal and the mesenteric lymph glands. It usually affects the lower end of the small intestine, the cecum, and the first part of the large intestine. However the condition may extend the entire length of the intestinal tract.

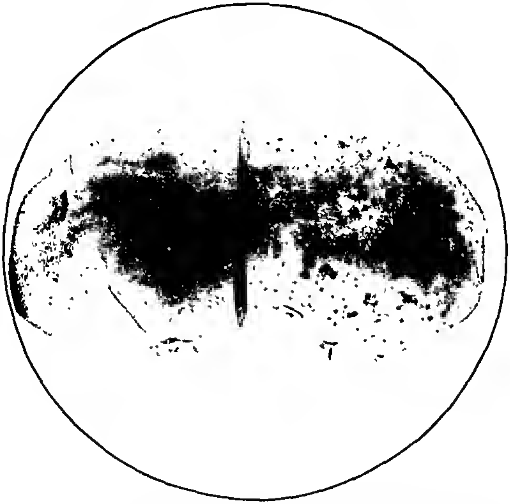

FIG. 27.—Portion of normal kidney on the left for comparison with abnormal "turkey egg" kidney on the right showing hemorrhages typical of hog cholera.

*Lesions.*—The mesenteric lymph glands do not show any marked change. There is usually only a slight enlargement of these glands. A marked thickening of the intestinal wall characterizes the disease. This results from a diffuse proliferation of epithelioid cells usually accompanied with thickening of the mucous membrane and the submucosa.

*Post-Mortem Significance.*—Carcasses affected with this condition which show any systemic change or emaciation are unfit for food. Usually the condition is localized in the intestinal tract with no apparent effect on the carcass, in which case the carcass is passed for food after elimination of the diseased viscera.

**Listerellosis.**—Animals showing symptoms of this condition are not fit for slaughter as food animals. However, animals which have recovered from the condition are passed for slaughter and their carcasses are presented for meat inspection post-mortem examination.

*Etiology and Pathogenesis.*—The condition is caused by *Listerella monocytogenes* which invade the central nervous system.

*Lesions.*—No lesions caused by the condition are seen on post-mortem examination of the carcass of an animal that has recovered from the disease. Histologically, the causative organism, if present, can be identified in sections of involved brain tissue.

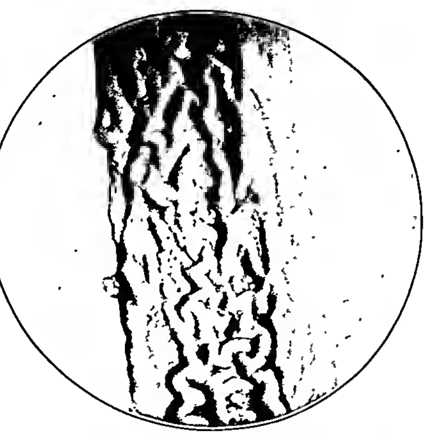

FIG. 28.—Thickened intestinal mucosa typical of paratuberculosis.

*Post-Mortem Significance.*—Since *Listerella monocytogenes* is known to persist in the brain tissue of an animal that has recovered from the infection, the carcass of such an animal if found otherwise acceptable on post-mortem examination is passed for food after removal and condemnation of the head.

**Blackleg.**—This condition is generally found in cattle but it may also affect other ruminants.

*Etiology and Pathogenesis.* The *Clostridium feseri* is the causative agent. It is believed that the infection occurs through the digestive tract. The infection localizes in muscle tissue, usually in the region of the shoulder or of the rump producing a diffuse swelling.

*Lesions.*—The affected muscular area is swollen and edematous with a

characteristic emphysema. The affected area becomes dark-brown to blackish in color as the condition progresses. It is reported that the lesion possesses a characteristic sweetish-sour, pungent odor.

*Post-Mortem Significance.*—Carcasses affected with this condition are unfit for food.

**Piroplasmosis.**—This condition in cattle is commonly called Texas fever. It is tick-borne.

*Etiology and Pathogenesis.*—*Babesia bigemina* is the causative organism. This organism is transmitted from infected animals to other animals by the tick *Margaropus annulatus.* The organism attacks and destroys the erythrocytes. The changes which occur in the body are those associated with extensive blood cell destruction.

*Lesions.*—The spleen, liver, and kidneys become swollen and this is accompanied with progressive anemia and icterus affecting the carcass. The most conspicuous change involves the spleen which enlarges up to 4 times its normal size, taking on a reddish-brown color. The bile ducts are engorged and the gall bladder is distended with thick, dark-colored, flocculent bile. The urine is sometimes tinged with blood pigment.

*Post-Mortem Significance.*—Carcasses affected with this condition are unfit for food.

**Vesicular Stomatitis.**—This disease affects cattle and occurs rarely in swine.

*Etiology and Pathogenesis.*—The condition is caused by a filterable virus which produces vesicles on the lips, mouth, and tongue. Also, vesicles form on the udders of cattle occasionally and rarely on their feet.

*Lesions.*—The vesicles become quite large and when they break the denuded tissue is usually infected by a secondary invader producing sores which gradually heal as the disease subsides.

*Post-Mortem Significance.*—A carcass affected with this condition in the acute stages or where the carcass shows any systemic involvement is unfit for food. In those cases where the disease has subsided and the condition is localized in the affected part, the carcass is passed for food after removal of the diseased portion.

**Vesicular Exanthema.**—This condition affects swine principally. Otherwise it is very similar to vesicular stomatitis supra. It is caused by a filterable virus and the lesions are similar to vesicular stomatitis. It has the same post-mortem significance.

**Neoplasms.**—A large number and a great variety of tumors are encountered in connection with meat inspection post-mortem examinations made in large packing plants where many animals are slaughtered for food. Insofar as affecting the disposition of a carcass is concerned, there are two principal considerations, first, is the neoplasm benign or malignant, second, is the involvement such as to indicate the probability of metastasis. Accordingly, no consideration is being given here to identifying the many kinds of tumors as they are classified according to tissue involved or type of cellular structure in the malignant ones.

In a two-year survey of tumors occurring in cattle, sheep, and swine, submitted for slaughter at Denver's federally inspected abattoirs, 1,002 tumors were collected; 908 bovine, 66 ovine, and 28 porcine tumors.

Of the 908 bovine tumors, 722 were squamous cell *neoplasms of the eye*

and were found in 532 cattle during the first year of the survey. The collection of eye tumors was limited to those found in selected abattoirs during one year; their frequent occurrence made them the most important neoplasm encountered in cattle. A diagnosis of squamous cell carcinoma was made in 471 of the 722 eye tumors.

The comparative frequent occurrence of adenocarcinomas of the uterus and lymphosarcomas in cattle in this survey and their predictable early fatal termination made them both economically important. Schwann's cell and adrenal cortical tumors were common bovine tumors with a relatively benign behavior. Liver cell tumors, granulosa cell tumors of the ovary, and epithelial lung tumors of cattle were not found as frequently as had been anticipated.

FIG. 29.—Embryonal nephroma—hog.

Neoplastic diseases in slaughtered sheep and swine are much less important than in cattle. Epithelial tumors were equal in occurrence to the nonepithelial tumors in sheep but were not found in swine in the survey. Lymphosarcomas would appear to be the tumor of the greatest economic importance in both sheep and swine. Embryonal nephromas were the most common tumor diagnosed in swine

*Benign Tumors.*—The tumors making up this class vary considerably in size and consistency. They are made up of proliferations of a normal body tissue. They are circumscribed, non-inflammatory, and show no inclination to invade the surrounding tissue. After removal of such a tumor, the carcass is passed as fit for food.

*Sarcomas.*—Malignant connective-tissue tumors make up this class. Sarcomas are highly cellular tumors. The stroma is very scanty and is

distributed between the individual cells. The nature of the cells depends on the type of tissue from which the neoplasm has developed. This type of tumor has unlimited powers of growth. It invades the surrounding tissues and spreads by metastasis. Any organ or part affected with a sarcoma is unfit for food. The entire carcass is unfit for food when the neoplasm is extensive or affects the muscles, skeleton, or body lymph glands, or when there is metastasis.

*Carcinomas.*—These are malignant epithelial tumors. They occur anywhere in the body where there is epithelium, such as the skin, mouth, alimentary canal, glands, bladder, ureter, and so forth. They are rarely found in young animals. The neoplasm forms by the epithelial cells

FIG. 30.—Malignant lymphoma, leaf fat of hog.

breaking through the basement membrane and extending into the neighboring tissue. Carcinomas possess striking infiltrative powers. They have no definite capsule and their growth is quite irregular. By contrast with the sarcoma, there is no intercellular stroma in the carcinoma. The carcinoma is characterized by groups or islands of epithelial cells imbedded in a connective tissue stroma. The most common carcinoma found in connection with meat inspection post-mortem examinations is epithelioma of the eye of cattle.

(a) Carcasses of animals affected with epithelioma of the eye, of the orbital region, and/or of the corresponding parotid lymph gland are condemned in their entirety if one of the following three conditions exists:

(1) The affection has involved the osseous structures of the head with extensive infection, suppuration, and necrosis;

(2) There is metastasis from the eye, the orbital region, and/or the corresponding parotid lymph gland to other lymph glands, internal organs, muscles, skeleton, or other structures, regardless of the extent of the primary tumor; or

(3) The affection, regardless of extent, is associated with cachexia or evidence of absorption or secondary changes.

(*b*) Carcasses of animals affected with epithelioma of the eye, of the orbital region, and/or of the corresponding parotid lymph gland to a lesser extent than in paragraph (a) of this section may be passed for food after removal and condemnation of the head, including the tongue: *Provided*, The carcass is otherwise in good condition.

FIG. 31.—Carcinoma eye, eyelid, lymph node bovine.

**Retrogressive Systemic Changes in Very Young Animals.**—This condition develops during the few days immediately after birth during which the young animal is adjusting itself to its new environment. The condition has significance in calves principally since other species of animals are only rarely slaughtered for food soon after birth. As the retrogressive condition develops, the muscles of the carcass become grayish-red and have a water-soaked appearance, serous infiltration and edematous patches occur in the musculature, and the sublumbar and perirenal tissue become edematous and take on a dirty yellow or grayish-red appearance. There is a tendency for an icteric condition to develop. Carcasses of young calves showing this condition are unfit for food. Care is exercised to distinguish between carcasses affected with this condition and the carcasses of calves which have been fed on a fat deficient diet. The absence of fat from the carcass of a calf is not in itself an indication of unfitness for food. Calves which are characterized by merely an absence of fat are generally older

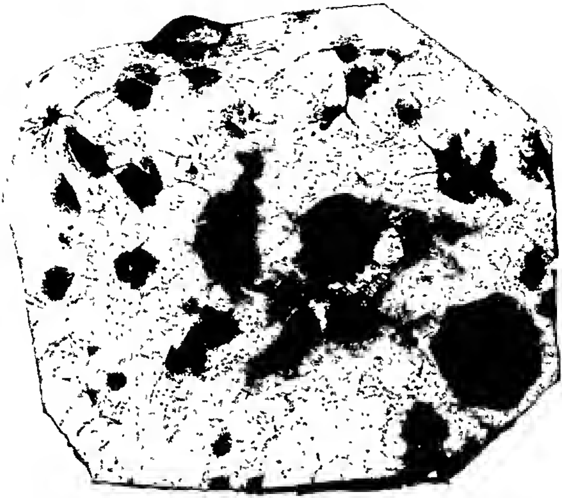

FIG. 32.—Metastatic malignant melanoma in a hog lung—the primary tumor was in the skin.

FIG. 33.—Emaciation, gelatinous degeneration of cardiac fat in sheep (right), normal heart on left.

than the calves affected with the condition described in this chapter and their musculature is firm and of good color.

**Emaciation.**—This condition is generally observed in old cows. It is probably produced by a combination of causes. Generally, there is no identifiable cause found when the carcass of the animal is examined on post-mortem meat inspection. There is a characteristic slimy degeneration of the tissues where fat is normally deposited. Also, a serous infiltration of the muscles is sometimes observed. A carcass affected with this condition is unfit for food. Care is exercised to distinguish this condition from mere leanness of a carcass since the absence of fat does not make a carcass unfit for food.

**Anasarca.**—This name is given to a condition which is seen occasionally in cattle, principally in well-fed steers. It is characterized by an edema occurring subcutaneously and intermuscularly in the shoulder region and

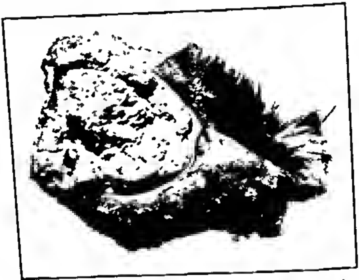

FIG. 34.—Carcinomatous growth involving the entire orbital region of a steer.

brisket. The cause of the condition is believed to be dietary and has been attributed to a vitamin A deficiency. The disposition of an affected carcass depends on the extent of the edema. Where the involvement is limited so as to permit removal of the affected tissue, the remainder of the carcass is passed for food. The condition is rarely of an extent which would make the entire carcass unfit for food.

**Pale Muscle Tissue.**—This condition is observed principally in the carcasses of swine. It is not the condition caused by fat infiltration of musculature (page 124). The pale muscle condition is observed without any accompanying pathological condition. Sometimes the pale muscles are soft and have a watery appearance. Such carcasses may not chill out as firmly as normal muscle tissue.

At one time the pale muscle condition of swine was considered to be a degenerative change. Histologically, there are not sufficient pathological alterations of the muscle fibers to justify calling the condition a degenerative

one. A few muscle fibers appear swollen and the cross striations are indistinct. The paleness in color appears to be due to a deficiency in the muscle pigment, myoglobin. In this connection it is significant that the myoglobin of the pale muscle tissue reacts normally to treatment with sodium nitrite.

Carcasses affected with this condition in which the musculature is normal in all respects except as to the pale color are passed for food.

**Pigmentation.**—Pigment is either exogenous or endogenous depending on whether it is introduced into the body from the outside or whether it occurs normally in the body.

EXOGENOUS PIGMENTS.—These pigments are introduced into the body of the animal from the outside. Those of importance in meat hygiene enter the body with the food ingested by the animal. They consist principally of the carotinoid pigments. When the carotinoid pigments occur in the body deposited in the fat, they are of meat hygiene significance only insofar as it is necessary to distinguish the condition from discoloration of tissues with bile pigments. This can be readily done by examining the white fibrous connective tissue which retains its white color when the pigmentation is carotinoid in nature. When bile pigments cause the coloration, the white fibrous connective tissue has a yellow cast.

Carotinosis of the liver is caused by the deposit of carotinoid pigments in that organ in an abnormally large amount.

The fitness of a carcass for food is not affected by the deposit of carotinoid pigments in the fatty tisssue. Extensive carotinosis of the liver makes that organ unfit for food.

ENDOGENOUS PIGMENTS.—These are natural to the body and normally take part in its metabolism. They assume meat hygiene significance when they are present in abnormally large amounts or in an abnormal location in the body.

*Melanosis.*—There are probably several varieties of the pigment melanin which cause this condition. It is the pigment which is basically black and found normally in the skin, the hair, the choroid coat of the eye, the pia mater, and at the base of the brain. The abnormal distribution of this pigment is most commonly encountered during meat inspection post-mortem examinations made on sheep carcasses. It is seen in the connective tissue of the facias extending deep into the musculature. It is also commonly seen in organs principally the lungs and liver. Organs and carcasses affected with this condition are passed for food after removal of all of the affected tissue. When complete removal cannot be accomplished with certainty, the organ or carcass so affected is unfit for food.

Melanotic deposits are frequently found in the subscapular and axillary space of white and gray horses. These areas should therefore be exposed as part of the post-mortem examination in all carcasses from white and gray horses (identified before the hide is removed) and in horse carcasses where melanotic deposits are found elsewhere. The examination should extend to the ribs and costal muscles when deposits of melanin are found in the axillary space. Melanin may also be found in the bronchial and mediastinal lymph nodes, and organs of the abdominal, thoracic and pelvic regions. Fat and connective tissue in these areas may also be involved. Deposits of melanin

are normally found in the surface of the tongue, lips and palate of certain animals.

When not associated with characteristic malignant tumor formation, deposits of melanin located in the muscle, connective tissue, periosteum and fat shall be radically removed and the unaffected portion of the carcass, organ, or part of the carcass may be passed for food after removal and condemnation of the affected portions.

FIG 35 —Melanosis, melanin deposits in the heart of a steer.

If the character and location of the melanin deposits are such that complete extirpation is difficult and uncertainly accomplished or if the deposits render the organ or parts unfit for food, the affected organs or parts shall be condemned. When melanin deposits are found to be distributed in the carcass or part in such manner that removal is impractical, the carcass or part shall be condemned.

The slight melanin deposits occasionally found in the spinal meninges are not regarded as being significant unless it is determined that the deposits are also present in the sheaths of the spinal nerves and extend into the meat. If this is found, it may be necessary to bone the affected part or parts to remove the deposits of melanin.

In hogs, uniform melanin deposits over the skin or in circumscribed areas in the skin need not be removed unless the character is such that melanin deposits are tumorous or smeary.

*Ochronosis.*—The pigment causing this condition is considered to be in the general order of the melanins. Ochronosis is characterized by a black discoloration of cartilages, joint capsules, tendons, and ligaments. It is seen in cattle and hogs. Where the affected tissue can be removed the carcass is fit for food. In those cases where the involvement is so extensive as not to permit removal of all the affected tissue, the carcass is unfit for food.

*Osteohemochromatosis (Porphyria or Pink Tooth).*—This is a yellowish-brown pigmentation of blood origin. The principal pigment is an abnormal porphyrin produced as a result of disarrangement of hemoglobin metabolism. This condition occurs in cattle and hogs where it is characterized by a reddish-brown to chocolate-brown discoloration of the bones. It may also occur in the liver and spleen. Where the affected tissue can be removed, the unaffected portions of the carcass are passed for food. Organs affected with this condition to a slight extent and not associated with any cirrhosis or other secondary changes are passed for food, otherwise they are unfit for food.

This condition has also been described as being due to a deficiency of apoferritine, a protein synthesized by the body and forming ferritine in combination with stored iron. When an insufficient quantity of apoferritine is produced, it is supersaturated with iron and thus gives rise to the formation of hemosiderin which is a pathological ferric deposit and not a physiological one like ferritine.

*Icterus.*—This condition is caused by the bile pigment bilirubin. The bilirubin is sometimes accompanied with its oxidized form, biliverdin. This pigmentation is characterized by a bright yellow discoloration of all of the body tissues noticeable principally in those tissues which are normally light-colored, such as adipose tissue and white fibrous connective tissue. The degree of discoloration varies from a very slight yellow to a decided greenish-yellow. Icterus is associated with many infectious and inflammatory conditions affecting animals. The significance of icterus with respect to those conditions has been discussed in connection with each. Carcasses are unfit for food when the discoloration is well marked. When the discoloration is slight and disappears on chilling the carcass, it is passed for food provided there is no other condition which would require a different disposition.

*Xanthosis (Brown Atrophy of the Musculature).*—This is essentially a discoloration of musculature resulting from deposition of excessive quantities of waste pigment. The degree of atrophy is variable. It is usually found in old cattle and is most noticeable in the muscles of the heart, the masseter muscles, and in the tongue. When this condition results in an extensive discoloration of the musculature of the carcass, it is unfit for

food. Where the condition is slight and localized, the carcass is passed for food.

**Offensive Odor.**—Carcasses occasionally exhibit abnormal odors which in some cases are offensive. The offensive odors which affect the disposition of carcasses on meat inspection post-mortem examinations come within two categories: those traceable to materials ingested by the animal, and the odor known as sexual odor in swine.

The most common offensive odor traced to feed ingested by food animals is often described as being fishy in nature. It is assumed that this fishy odor occurs in the carcasses of animals which have been fed fish meal or other feed of fish origin. Occasionally, a distinct garlic odor is detected in a carcass. This generally occurs in the spring and is thought to be produced by a generous feeding of wild garlic. Also, certain drugs which have been administered to the animal prior to slaughter impart to its carcass an odor characteristic of the particular drug.

Carcasses which have an offensive odor are not fit for food. Occasionally, the odor which is detected at the time of slaughter will disappear upon chilling and holding the chilled carcass for a period of time. In any case, a carcass which is retained for having an offensive odor is not passed for food until a test is made of a representative portion of its fat and muscle tissue by heating.

*Sexual.*—An offensive sexual odor is sometimes detected in carcasses of boars and recently castrated stags. Care is exercised to distinguish this condition from an odor which is imparted to a part of a carcass by contamination with smegma from the prepuce.

Some carcasses that exhibit sexual odor will lose the odor after the carcass is chilled and held for a period of time. Here again no such carcass is passed for food until a test has been made of representative portions of fat and muscle tissue by heating. A carcass which has a sexual odor is unfit for food. The portion of the carcass which has been contaminated with smegma is eliminated by trimming and the clean portion of the carcass is passed for food. Washing of a carcass that is in part contaminated with smegma is not attempted since such handling would spread the contamination and require trimming of a larger portion before the carcass is passed for food.

**Mesenteric Emphysema of Hogs.**—This condition is characterized by the presence in the mesenteric fat of numerous air-filled cysts occurring both singly and in grape-like clusters. The cysts vary considerably in size from a pinpoint to approximately 1 inch in diameter. They are tightly filled with air and are usually transparent.

The cause of this condition has not been definitely established. It is benign and non-inflammatory. It appears to have no effect on the animal or the tissues where the cysts are located.

This condition does not affect the disposition of a carcass which is passed as fit for food. It interferes somewhat with the handling of the small intestines in connection with their preparation for use as animal casings.

**Liver Conditions.**—*Cirrhosis.*—This is observed most commonly affecting the livers of swine on post-mortem meat inspection. It is characterized by a proliferation of the interstitial tissue which eventually takes

on the characteristic of cicatricial tissue. The liver is firm in texture and its surface sometimes becomes rough, having a characteristic "hobnail" appearance. Livers affected with this condition are unfit for food.

*Carotinosis.*—Carotinoid pigmentation of the liver is quite common in cattle. When this pigmentation is extensive and produces a highly colored yellow condition throughout the liver and its lymph glands, the liver becomes enlarged and friable. The pigment stains the hands and other objects which the affected liver contacts. Such a liver is unfit for food.

*"Sawdust" and Telangiectasis.*—So-called "sawdust" and "telang" lesions are considered as representing different stages of a focal hepatitis and its termination. These lesions are seen in cattle livers, the typical telangiectatic lesions usually occurring in the livers of older animals.

According to Getty (1946) areas of capillary congestion represent the first stage of the focal hepatitis. In subsequent stages there is degeneration of the hepatic parenchyma (focal necrosis) and a localized inflammatory reaction producing the characteristic "sawdust" lesion. The typical telangiectatic lesion represents the final stage or termination of the process following resolution of the "sawdust" lesions. No evidence is found that infection is associated with the process which progresses to the "sawdust" and telangiectasis stages.

The "sawdust" lesion is pinkish-white to yellow-gray and is variable in distribution. The area surrounding the lesion appears normal. The surface of the liver over the lesion is smooth and no proliferation of tissue or hypertrophy is evident on palpation.

The "sawdust" lesion gives way to a dilatation of the hepatic sinusoids during resolution and repair by regeneration. This develops into the telangiectasis lesion which is purplish-black to reddish-blue and the lesions vary greatly in size. The lesions consist of tar-like blood and have a cavernous appearance. They are definitely circumscribed areas ranging from those which are readily overlooked to large areas which contrast markedly with the surrounding normal liver tissue. There is no encapsulation or other apparent reaction of the surrounding tissue noticeable to the unaided eye. The areas are not elevated above the surface of the liver, in fact, some of the larger ones may be slightly sunken.

Anderson (1955) describes telangiectasis as resulting from a parenchymal erosion rather than from hepatic necrosis. He explains the earliest alteration in telangiectasis results from extracellular glycogen causing separation of the endothelium from hepatic cells. The normal flow of blood into this area between the endothelium and the hepatic cells causes erosion of the hepatic cells which continues until the healthy surrounding parenchyma is capable of supporting the flow of blood. These blood spaces constitute cavernous telangiectasis.

Cattle livers and calf livers showing "telangiectasis" or "sawdust" are disposed of as follows:

(1) When any or all of the conditions are extensive and involve one-half or more of an organ, the whole organ shall be condemned.

(2) When any or all of the conditions are slight in an organ, the whole organ shall be passed without restriction.

(3) When any or all of the conditions involve the whole organ, and are

less severe than extensive, but more severe than slight, the whole organ shall be cooked.

(4) When any or all of the conditions are less severe than extensive, but more severe than slight in a portion of an organ, while in the remainder of the organ the conditions are slight, the remainder shall be passed without restriction and the other portion shall be cooked.

(5) When any or all of the conditions are extensive and involve less than one-half of the organ, while in the remainder of the organ the conditions are slight, the remainder shall be passed without restriction and the other portion shall be condemned.

(6) When any or all of the conditions are extensive and involve less than one-half of the organ, while in any or all of the remainder of the organ the conditions are more severe than slight yet less severe than extensive, all of the remainder shall be cooked and the extensively involved portion shall be condemned.

(7) The division of an organ into two parts as herein contemplated for disposition, shall be accomplished by one cut through the organ. This, of course, does not prohibit incisions which are necessary for inspection.

(8) Livers and parts of livers which are required to be cooked shall be held and cooked in the establishment where produced. They shall be cooked sufficiently to impart a cooked appearance throughout the liver. After cooking, the liver may be released for any purpose.

*Abscesses.*—This is a very common condition affecting livers of all species. The abscesses are caused by a variety of etiological factors, frequently being associated with specific disease conditions but generally occurring as a localized liver condition. The occurrence of liver lesions in connection with specific disease conditions has been mentioned in the consideration given to the particular condition. In all cases, a liver containing an abscess is unfit for food.

*Gallstones.*—Gallstones are commonly observed in the gall bladder of cattle. They are generally present without any accompanying inflammatory or secondary change. Frequently, the mucous membrane of the gall bladder is slightly thickened and sometimes the bladder itself is somewhat distended.

The condition is benign and localized, and it is only rarely accompanied with any inflammatory change. Gallstones are saved by the packing industry and it is understood that they have some value as charms in the Orient.

**Abrasions, Bruises and Abscesses.**—Abrasions are of significance principally in hog carcasses because these carcasses are dressed with the skin on. They are also encountered, however, on the tongue and inside the cheeks of all species. The abrasions are usually localized inflammatory conditions associated with some degree of infection. The affected tissue is removed and handled as inedible. Abrasions sometimes do become infected to a degree involving extensive inflammatory changes. In such cases, careful examination of the carcass is made to detect any systemic change which might be evidence of absorption of toxic substances from the infected area. Where there is evidence of such systemic involvement the carcass is unfit for food.

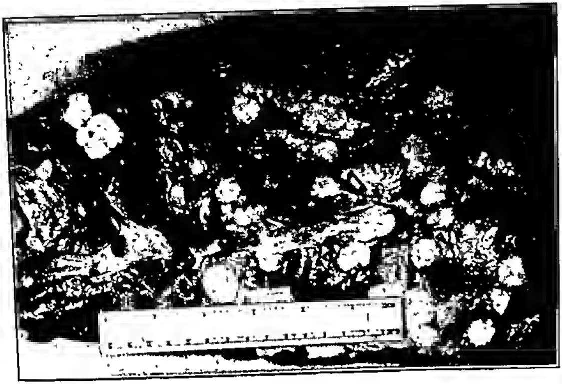

FIG. 36.—Necrobacillosis—bovine liver.

FIG. 37.—Parasitic scars in a hog liver.

Bruises varying considerably in degree and location are commonly found in many carcasses of all species on meat inspection post-mortem examinations. They are generally localized and circumscribed which permits the affected tissue to be removed and handled as inedible. In such cases the carcass is passed for food. Extensive bruises sometimes associated with bone fractures are occasionally encountered located in the thigh of swine carcasses. Sometimes these conditions are deep and not readily observed on the surface of the carcass. Evidence of such condition, however, shows itself by a hemorrhagic appearance of the lymph glands draining the area. Generally, there is no systemic involvement associated with bruises, however, occasionally there is found such extensive tissue destruction caused by contusions as to affect the entire carcass which is then disposed of as being unfit for food.

Of the great variety of kinds and locations of bruises encountered in carcasses of food animals there is one which occurs with a high degree of uniformity that has lent itself to study and investigation. It has been demonstrated repeatedly that the ham has more costly bruises than any part of the swine carcasses, and there is a characteristic ham bruise referred to as a bloody spot on the medial surface of the ham, which occurs most frequently and is most costly for the packer. This condition has been found to be not a conventional bruise, but it is due to hemorrhage into and an escape of bloody synovial fluid from the hip-joint into the intermuscular septa of the quadriceps femoris muscle.

This hemorrhaging is brought about largely by the process of shackling a live hog and also to a minor extent to rough handling of the carcass when gambreling. Evidence indicates that shackling is responsible for the production of most of the external hip-joint hemorrhages in ham. Studies show that the gambreling is responsible for the production of most of the internal hip-joint hemorrhages.

The shackling process is significant in the production of external hip-joint hemorrhages both because it tears the round ligaments and the joint capsules, and tears them while the animal is still alive. The blood, and the synovial fluid escape into the intermuscular septa through the tear in the joint capsule. The hemorrhaging may result in a hematoma of considerable size.

The internal hip-joint hemorrhage is produced as follows: At the time of gambreling the weight of the carcass and the stress of dropping rapidly on the gambrel result in the tearing of the round ligament and its blood vessel. Although the animal has been bled out and its heart action has stopped a quantity of it remains in the vascular system. When the carcass is suspended by the gambrel its weight is transferred to muscles of the hip-limb and the skin is tightened. This could apply pressure to the residual blood through the torn vessel into the joint where, mixing with the synovial fluid, a significant amount of blood discolored liquid will appear.

Of course, an internal hip-joint hemorrhage may be produced by shackling, and an external hip-joint hemorrhage may be produced by gambreling. If the shackling stress is insufficient to break the joint capsule, an internal hemorrhage will occur. Similarly, if the hemorrhage gambreling stress is sufficient to break the joint capsule, an external hemorrhage will be pro-

duced. The two can readily be distinguished by the amount of hemorrhaging. The amount of hemorrhaging is greater at the time of shackling because the animal has not yet been bled.

Abscesses are encountered in many locations throughout the carcass and its viscera. Those which occur in connection with a specific infectious condition have been mentioned in discussions concerning those conditions. Frequently, the abscess is not associated with any other condition in the carcass, but is a localized, circumscribed involvement. In such case the carcass is passed for food after elimination of the affected tissue or organ. Abscesses occur with a high degree of frequency in the jowl of swine. These are embedded in the jowl and may or may not be associated with abscesses

FIG. 38.—Vaccination abscess hip muscle of hog.

in the cervical lymph gland. These abscesses have been identified with streptococcus infection that gains entrance through the pharyngeal mucosa and probably the nasal mucosa. This same phenomenon might be identified with the rather high incidence of abscesses found in swine tongues.

Needle grass awns are sometimes found to occur rather extensively in the subcutaneous tissue and extending into the superficial musculature of Western lambs. The awns are imbedded in the flesh where they are readily detected by inspection even though there may be little or no response to their presence. They appear as a small black spicule that is readily discernible to the eye and by palpation. The condition is invariably localized and the carcass is passed for food after removing the strips of affected tissue.

**Sapremia and Toxemia.**—These toxic conditions are considered together inasmuch as they have comparable significance with respect to meat inspec-

tion post-mortem examinations. Furthermore, it is very nearly impossible to distinguish between the two conditions on such examination.

From the point of view of meat hygiene these conditions are systemic manifestations indicating the extent to which a carcass is affected by some primary condition. Generally, the primary condition is the one which is identified as the cause for condemnation of the carcass. When there is any evidence in a carcass of sapremia or toxemia, it is unfit for food.

**Uremia.**—This condition is also encountered as a manifestation of a primary condition, usually involving the kidneys. Theoretically, it might occur as a result of the retention of urine caused by an obstruction of the urethra. The condition is detected by its offensive urinous odor. A carcass so affected is unfit for food.

**Pyemia.**—This condition as it is found on meat inspection post-mortem examinations is characterized by the occurrence of multiple abscesses generally distributed throughout one or both body cavities. There is usually a primary seat of infection from which the pyogenic organisms were distributed in the blood stream to the secondary locations. A carcass so affected is unfit for food.

**Urticaria and Erythema.**—These abnormal skin conditions occur in connection with both infectious and parasitic conditions. Their significance has been considered in discussions of these conditions.

Urticaria and erythema sometimes occur as localized skin conditions as the only abnormal condition affecting the swine carcass. They are of significance only in disposing of swine carcasses since such carcasses are dressed with the skin on, the skin forming part of the edible portions of the carcass. When these conditions occur, the affected tissue is removed and the carcass, if otherwise acceptable, is passed for food.

**General Inflammatory Conditions.**—In those cases where the inflammatory conditions which are listed under this heading occur in connection with a specific infectious or parasitic condition, they have been mentioned in discussions of those conditions. Occasionally, there is an inflammatory process involving a particular organ or part as the primary condition.

**Mastitis.**—The udder is a common seat of infection in cows which are slaughtered for food purposes. Generally, the udder is discarded as an article of human food, in which case only those inflammations of this organ that are accompanied with systemic involvement are of significance. A carcass so affected is unfit for food. Mastitis in any degree makes the organ unfit for food.

**Gastritis.**—Inflammations involving the mucosa of the stomach are of significance only if they are diffuse and acute in which case they are invariably accompanied by systemic changes that make the carcass unfit for food. The swine stomach and the first two stomachs of cattle are the only ones generally saved for human food. These are scalded as part of their preparation which treatment completely removes the superficial mucous membrane. Small areas of hyperemia occur quite commonly in these stomachs, however, such involvement is considered to be unimportant from the point of view of meat hygiene in view of the method used in preparing the stomachs for food. Abscess of the reticulum is a common

condition resulting from injury by foreign bodies which accumulate in this organ. An abscessed reticulum is unfit for food.

**Enteritis.**—Like gastritis, this condition has significance with respect to the disposition of the carcass only when the inflammation is acute and diffuse and associated with systemic manifestations. A carcass so affected is unfit for food.

Chitterlings are the only intestines prepared as an article of human food. They are the large intestines of swine. Commonly, an area of inflammation occurs near the ileocecal opening in the large intestine of swine. The affected area is removed when this intestine is used in the preparation of chitterlings.

**Pneumonia.**—Bronchial pneumonia is quite common in all species. It may be produced by many causes. All affected lungs are unfit for food. The condition makes the carcass unfit for food when the pneumonia is of such extent as to be associated with systemic changes.

Lobar pneumonia occurs less frequently and is most commonly observed in swine. It is usually associated with systemic involvement which makes the carcass unfit for food.

**Pleuritis.**—Localized resolved areas of pleuritis are commonly observed in all species, associated with adhesions varying considerably in extent. There may also be localized abscess formation. Such conditions being localized permit passing the carcass for food after removal of the affected part. Occasionally, acute, diffuse inflammation of the pleura occurs associated with systemic change which makes the carcass unfit for food.

**Pericarditis.**—Inflammation of the pericardium is principally observed in cattle as a result of foreign body penetration from the reticulum. Occasionally, the condition is localized with the formation of adhesions. Sometimes there is localized abscess formation. Frequently the inflammation is acute, diffuse, and purulent, and associated with systemic change making the carcass so affected unfit for food.

**Nephritis.**—As a primary condition, nephritis occurs occasionally as a focal suppurative condition in swine and, rarely, in old cattle. In swine the condition is believed to be the result of housing swine under filthy conditions. The infection is thought to work its way up the urinary tract to the kidney where an inflammation of the hilus and tubules occurs. It produces an enlargement of the affected kidney with accompanying accumulation of pus. The condition tends to localize, in which case the carcass is passed for food after removal of the affected tissue. The carcass is unfit for food if the condition is accompanied with systemic change.

There is a benign condition affecting the kidneys of young calves which is characterized by the occurrence of light-colored to white embolic areas throughout the body of the kidney. This condition has been called fibroplastic nephritis and it appears to have no effect on the health of the animal since the condition is usually seen in carcasses of good condition. In fact, the kidney appears to be functioning normally. Kidneys so affected are unfit for food and after their elimination, the carcass, if otherwise acceptable, is passed for food.

**Metritis.**—Inflammations of the uterus are commonly encountered in conducting meat inspection post-mortem examinations of cows. The

degree and kind of inflammation vary considerably. Also, the condition may be accompanied with a retained dead fetus or placenta. If the condition is localized and not associated with systemic change, the carcass is passed for food. In any case all uteri are handled as inedible. Where the inflammation is acute and diffuse and associated with systemic change, the carcass is unfit for food.

**Arthritis.**—As a primary condition, an inflammation of a joint is usually caused by an injury. This is a localized condition and a carcass so affected is passed for food after removal of the affected tissue.

FIG. 39.—Hyperkeratosis—epithelial proliferation in bovine tongue.

*Post-Mortem Significance.*—When the condition is localized and not accompanied with systemic change, the carcass is passed for food after the removal of the affected parts. Otherwise the carcass is unfit for food.

**Selenium Poisoning.**—This condition is discussed under "Ante-Mortem" on page 42. The animal is not passed for slaughter unless it has responded to treatment for correction of the condition.

*Lesions.*—New growth of the horny tissue of the foot is seen pushing off the old horn. There is a distinct line of demarcation between the two. Eccymotic spots may be seen on the epiglottis. A catarrhal inflammation may be present affecting the stomach. There may be areas of inflammation in the intestinal tract.

*Post-Mortem Significance.*—A carcass showing viscera lesions is unfit for food since such lesions are an indication that the toxic effect of the poisoning had not been corrected. A carcass showing no visceral lesions or systemic involvement is passed for food.

**Fluorine Poisoning.**—This is discussed under "Ante-Mortem" on page 43. The condition is characterized by an interference with calcium metabolism.

*Lesions.*—The disturbed osseous metabolism results in great thickening and exostosis of the long bones and mandible. The ribs are flattened and enlarged. There is extensive abrasion of the molars and premolars. Hypoplasia of the enamel occurs. Degenerative changes occur in the liver, heart, kidney, and adrenal glands.

*Post-Mortem Significance.*—The carcass is unfit for food when degenerative changes are present in its organs. When the carcass is from an animal which has responded to treatment and no abnormality is found in its organs, it is passed for food after removal of all abnormal bones. The damage done to bones and teeth by the fluorine poisoning is not reversible even though the concentration of fluorine in the body is reduced to normal.

**Icterohemoglobinuria in Sheep.**—This condition occurs enzootically in sheep and is sometimes called "enzootic jaundice." It is also called hemolytic icterohemoglobinuria.

*Etiology and Pathogenesis.*—The condition appears to be due to a disturbance of copper metabolism associated with high storage values for copper in the liver and a sudden mobilization of copper in the blood stream. The condition occurs in the absence of excessive intake of copper and its manifestations are the same as the condition which results from chronic copper poisoning caused by long-continued ingestions of salt mixtures containing copper sulphate. The condition appears to be precipitated by a falling plane of nutrition such as might occur during shipment as a result of excessive exercise or a sudden check of food intake.

*Lesions.*—The condition is characterized by a true icterus accompanied with swelling of the spleen and degenerative changes in the liver and kidney.

*Post-Mortem Significance.*—A carcass affected with this condition is unfit for food.

**Osteomyelitis.**—This is an inflammation of the bone marrow and is most commonly seen in swine. However, it occasionally occurs in cattle.

*Etiology and Pathogenesis.*—Pyogenic organisms invade the bone marrow probably as a result of some predisposing factor.

*Lesions.*—The ribs are most frequently affected. The bone marrow is hyperemic with pus permeating the marrow cavity. As the condition progresses the resulting inflammation stimulates the production of new bone by the periosteum causing the bone to become enlarged.

*Post-Mortem Significance.*—The carcass is unfit for food when the inflammation of the bone marrow is accompanied with secondary changes in such organs as the liver, spleen, or kidneys, or accompanied with any other systemic change. In the absence of organ involvement or systemic change, the carcass is passed for food after removal of the affected parts.

**Steatosis.**—This condition is also called lipomatous atrophy and affects the muscle tissue of cattle. It is a non-inflammatory condition characterized by displacement by fat of a portion of the musculature. There is no swelling or atrophy to give notice of the presence of the fatty tissue. It is generally seen only when cut into as the carcass is being cut up into its various parts.

*Post-Mortem Significance.*—The presence of this condition does not influence the fitness for food of a carcass which is passed for food after removal of the abnormally located fatty tissue.

**Atrophic Rhinitis.**—This swine disease was first described in the United States in 1944. It receives considerable attention in the Cornbelt and other areas where swine concentrations are great.

*Etiology and Pathogenesis.*—Although the condition appears to be the result of an infection the causative agent has not been identified. During the course of the disease many secondary bacterial invaders influence the clinical picture. The disease is rarely fatal when uncomplicated but lowered resistance during its course may result in pneumonia, enteritis, or other infections.

*Lesions.*—A slight to moderate necrotic rhinitis with complete or almost complete absence of the nasal turbinate bones may be observed. Small amounts of pus or catarrhal exudate may be found in the nasal sinuses. The soft tissues of the turbinates may be present but are folded against the nasal cavity wall since the supporting bony structures are absent. In old cases, there may be abscesses in the lungs which are usually well circumscribed. These lesions are believed to be due to inhalation of tissue particles or exudate from the nose.

*Post-mortem Significance.*—When the involvement is localized, the affected portions are removed with care being exercised to avoid contaminatioo of the portions that are passed for food. When the condition is associated with systemic involvement, the entire carcass is unfit for food.

**Leptospirosis.**—This disease affects cattle, swine, and man. It is widespread throughout the United States. The severity of the disease ranges from inapparent, subclinical infection to severe, prostrating disease terminating in death. In man, the injection of the scleral blood vessels is so constant as to be almost pathognomonic of the disease.

*Etiology and Pathogenesis.*—Both bovine aod swine leptospirosis is caused by *L. pomona.* In the United States swine appear to act as the primary source of infection. The organism has been isolated from natural infections of cattle, swine, horses, sheep, goats, dogs, cats, mao, aod several species of rodents. Leptospirosis is almost always accompanied by the develop-

ment of chronic interstitial nephritis. The organisms continue to propogate in the kidney for extended periods of time and are shed in the urine. The disease is spread when other animals come in contact with this urine or with feed and water contaminated by it. The leptospira[1] enter the body through cut or abraded skin, the conjunctiva, or the mucous membranes of the nose and mouth. While the organisms do not live for extended periods outside the animal body, they remain alive long enough to travel considerable distances along waterways and they may live for days in poorly drained pastures or barnyards. The majority of porcine infections are subclinical. The symptoms of leptospirosis in cattle vary from a mild, inapparant infection which can be established only on the basis of serological evidence to an acute disease resulting in up to 33 percent deaths. It may appear as one or a combination of hemoglobinuria, mastitis, or abortion.

*Post-mortem Significance.*—Carcasses showing lesions of leptospirosis are unfit for food.

**Screw-worm.**—Any warm-blooded animal is susceptible to screw-worm attack. It has been known in Texas since about 1842. Its occurrence in the southeastern part of the United States dates back to the summer of 1933 when the first infestation was reported in the vicinity of Boston, Georgia.

*Etiology and Pathogenesis.*—The screw-worm is a true parasite and is the larval form of the screw-worm fly. Before the screw-worm fly will lay its eggs on an animal, there must be a disruption in the continuity of the body surface. This disruption may be as small as a tick bite. It may be through the navel cord of a new-born animal, a scratch, a surgical operation, or any abnormal condition affecting the skin or mucous membrane. The female screw-worm fly deposits her eggs in shingled batches on the edges of the wound of warm-blooded animals. She may deposit as few as ten or as many as 400 eggs at one time. The eggs hatch in from six to twenty-one hours.

*Lesions.*—The larvae eat into the live flesh, feeding in clusters and soon form a pocket in the flesh. The infective process extends rather rapidly to surrounding tissues. It causes considerable damage to livestock and frequently results in the death of young animals.

*Post-mortem Significance.*—When the infective process is localized, the tissue involved in the infection is removed and the carcass is passed for food. Where the involvement is extensive and accompanied with systemic changes, the carcass is condemned.

**Mucosal Disease of Cattle.**—An apparently new disease entity of cattle was encountered in Iowa in 1951 and named Mucosal Disease. The incidence has been greatest in winter and early spring, but it has occurred in every month of the year. The condition has been seen predominantly in Hereford and Aberdeen Angus cattle, but it has also been found in Shorthorn, Holstein-Friesian and Guernsey breeds.

*Etiology and Pathogenesis.*—Routine cultural studies of the liver, kidneys, spleen, and heart blood were negative for pathogenic bacteria. Transmission studies were inconclusive. Most of the affected animals have been between six and fourteen months of age. In about two-thirds of the cases, the course of the disease has been from five to fifteen days and from twenty to thirty days in the remainder. The morbidity rate varies from 2 to 50

percent in different herds and the mortality rate in affected animals has been about 90 percent.

*Lesions.*—The lesions are primarily erosive, ulcerative, and cystic confined principally to the lamina epithelia and mucosa of the alimentary tract. Lesions of the circulatory system consist of hyperemia, hemorrhages, thromboses, arteritis, periarteritis. Cloudy, swelling of the kidneys, and fatty degeneration and focal necrosis of the liver is observed.

*Post-mortem Significance.*—Carcasses showing systemic changes accompanying this disease are unfit for food.

**Toxoplasmosis.**—This is considered to be one of the very common infections of swine, however, most of the infections are well tolerated and it is only the exceptional, acute case that receives clinical attention. Data on prevalence derive not from clinical studies but from surveys based on serological data or skin tests. The transmission of the disease is not completely understood. A number of surveys on the prevalence of toxoplasmosis have been made. These indicate that the toxoplasma exists enzootically in a wide variety of hosts. The parasite is world-wide in distribution. It has been reported from every country and in all climates. It is known that the toxoplasmas are widely distributed throughout the body of the acutely infected hosts. However, the majority of infections with the parasite in nature are asymptomatic, the infective strains presumably having low virulence. The acute condition is characterized by a parasitemia.

*Etiology and Pathogenesis.*—*Toxoplasma gondii* is a parasite without host specificity among warm-blooded vertebrates. Differences of susceptibility of various animals to the parasite may be attributed to variations in host response and in strain virulence. There is indication that *toxoplasma gondii* exists enzootically in a wide variety of hosts. The parasite resembles in shape the merozoite of a coccidium. It is crescentic with one end attenuated and the other more rounded. Its dimensions are 2 to 4 microns in width and 4 to 7 microns in length. It requires an intracellular situation in order to grow and multiply. Many futile attempts have been made to cultivate the parasite in artificial media, however, it has been grown successfully on tissue cultures.

The parasite itself is an extremely sensitive organism. It is not resistant to the environment outside its host. The toxoplasma is killed by drying and by changes in osmotic pressure.

In chronic infections, the parasites are found as agglomerations within the remnants of parasitized cells. These bodies are termed "pseudo cysts" in that they resemble the encysted stages of other parasites. It has been suggested that the term "terminal colony" be used rather than "pseudo cysts" because of their origin from host cells enucleated as a result of the parasite. The toxoplasmas apparently occupy vacuolar spaces within the epithelial cells, and as they grow in numbers the space enlarges to include practically the entire cell volume. The occurrence of these cyst-like masses apparently explains the survival of the organism in tissues from animals chronically infected with the parasite. These pseudo cysts are known to be much more resistant than the individual parasite. The acute parasitemia manifestations of the disease are characterized by pneumonia,

lymphadenitis, hepatitis, splenomegaly, ulcerative and fibronecrotic colitis, and acute inflamed musculature. No lesions characterize the asymptomatic appearance of the disease.

*Post-mortem Significance.*—Carcasses affected with lesions characteristic of the acute stage of the disease are condemned.

**Poultry.**—The moving chain operating line on which the live bird is suspended carries its carcass through the entire dressing operations to the point where it is removed from the line as clean, wholesome poultry meat

FIG. 40.—Slaughtering Beltsville white turkeys. (U.S. Dept. of Agriculture).

and is promptly iced on its way to the consumer. The live poultry holding and handling area where the bird is hung on the line as it starts its journey through the poultry packing operation is separated from the poultry dressing department so as effectively to prevent dust, feathers, and other soilage from being blown into or carried into the poultry dressing department.

A bleeding knife has been developed that delivers a charge of electricity that stuns the bird simultaneously with the severing of the blood vessels. This serves the purpose of immobilizing the bird while bleeding. The so-

called "electric knife" is used principally in slaughtering turkeys to protect against the breakage of bones which sometimes occurs as the birds thrash about while bleeding.

The chain conveyor carries the bled carcass through the scalder in which the carcass is submerged in hot water that serves to loosen the feathers preparatory to their removal. Two scalding temperatures are employed. One of 123° to 130° F. is known as slight scald. This temperature loosens the feathers to some degree but it does not remove the keratinized epithelium from the skin. This water-impervious layer on the skin retards dehydration and bacterial growth. It is a valuable protective covering for poultry carcasses that are exposed to air during their handling and distribution.

The other scalding temperature ranges in the neighborhood of 141° to 142° F. This loosens the feathers completely but it also loosens the keratinized epithelium layer on the skin. Poultry carcasses produced with the use of the higher scalding temperatures are kept moist in cracked ice or they are protected by impervious packaging whether they are quick frozen or sold fresh. The advantage of the higher scalding temperatures is the practically complete removal of the pin feathers by the mechanical equipment, making this the most economical and therefore the most widely used method in the broiler industry.

The carcasses pass from the scalder to the mechanical ruffers. Here, under a spray of clean hot water a rough defeathering of the carcass is accomplished by a mechanical buffing operation. The feathers are mechanically separated from the spray water and removed to the inedible products department.

As the carcass is conveyed from the ruffers it still requires considerable finishing to remove the remaining feathers and pin feathers. The finishing is accomplished by a combination of mechanical and hand operations. The floor area under the conveyor lines where the scalding and defeathering is performed is depressed and pitched to drains to facilitate cleanup in the area and to accommodate splashing from the equipment. When the carcass is defeathered, it is singed to remove hair and then conveyed to the evisceration and inspection department.

To prevent contamination of edible tissues and to facilitate inspection, the carcass is carefully opened so as to present the entire carcass, including the internal and external body surfaces and all of the internal organs for thorough inspection. Care is exercised in opening the carcass so that no cut is made into the intestinal tract with resulting contamination of the carcass, operators, and inspectors' hands.

The three-point suspension is regarded as being the most desirable method of handling carcasses when presenting them for inspection except in the case of split fryers where the wing hang is preferred. The two-point suspension is not regarded favorably because it tends to make the sanitary evisceration operation difficult.

The Federal Poultry Inspection Service has identified the following as facilities to be provided at the evisceration and inspection position. A switch or button control should be available to the inspector so that the processing line may be stopped or started by him in connection with post-mortem and sanitation control. It is necessary to have adequate lighting

| Item | Philadelphia | Chicago | Des Moines | San Francisco | United States |
|---|---|---|---|---|---|
| | *Pounds* | *Pounds* | *Pounds* | *Pounds* | *Pounds* |
| Certified (Ready-to-Cook Weight) | 400,692,791 | 347,790,897 | 432,611,899 | 260,446,503 | 1,447,542,090 |
| Condemned (NY Dressed Weight) | 3,728,922 | 2,265,491 | 3,251,912 | 2,024,620 | 11,270,951 |
| Percent Condemned | .73% | .52% | .62% | .60% | .62% |
| | *Number* | *Number* | *Number* | *Number* | *Number* |
| Carcasses Condemned: | | | | | |
| Tuberculosis | 3,372 | 47,401 | 98,028 | 192 | 148,993 |
| Emaciation | 2,052 | 12,373 | 7,699 | 1,842 | 23,966 |
| Septicemia and Toxemia | 378,011 | 259,320 | 208,072 | 105,160 | 1,040,563 |
| Leucosis | 49,727 | 46,207 | 49,373 | 13,625 | 158,932 |
| Tumors | 57,457 | 61,364 | 35,647 | 24,202 | 178,670 |
| Inflammatory Processes | 431,075 | 224,633 | 135,738 | 119,608 | 911,654 |
| Parasites | 523 | 1,043 | 150 | 125 | 1,841 |
| Gout | 69 | 664 | 1,017 | 11 | 1,701 |
| Bruises | 21,712 | 27,965 | 20,743 | 8,240 | 81,660 |
| Contamination | 14,261 | 27,639 | 23,327 | 19,240 | 114,470 |
| Decomposition | 6,656 | 4,965 | 2,578 | 805 | 15,004 |
| Cadaver | 40,299 | 35,057 | 23,506 | 21,616 | 120,508 |
| Overscald | 8,679 | 7,665 | 4,254 | 2,524 | 23,122 |
| Other Causes | 3,337 | 5,242 | 58,092 | 602 | 67,273 |
| Total | 1,050,833 | 761,538 | 758,224 | 317,822 | 2,888,417 |

Official plants (eviscerating, canning or combination) as of 12/31/56—317 (Philadelphia—84; Chicago—81; Des Moines—108; San Francisco—44)

FIG. 11.—U. S. Department of Agriculture. Agricultural Marketing Service, Poultry Division, Inspection Branch. Summary of post mortem examination of poultry by specified areas for 1956.

of uniform intensity at all working levels. Double lines need dividers to prevent confusion and to assure that each carcass will receive the inspectors' attention. Shackle suspension should be placed as close as practicable on the line so that the maximum rate of production may be attained with a minimum chain speed. The production line conveyor should be synchronized with the conveyor belt or conveyor pans. Visceral organs including the heart are required to be presented in close proximity to the carcass from which they have been removed. For this purpose distances of 6 to 9 inches from carcasses are regarded as most practical. Hand-washing facilities are required to be adequate and properly located at both operating and inspecting positions.

The Service recommends placing a mirror approximately 8 inches by 30 inches at a 30 degree angle so located that the inspector can view the back side of the carcass without turning it for inspection. It is also recommended that a properly trained company employee accompany each inspector to perform such manual functions as picking feathers, trimming bruises, removing diseased birds from shackles and placing them in "condemned" cans, and, in general, assisting the inspector in routines related to the inspection procedures. A point is also made of the importance of having production lines adequately staffed with properly trained employees functioning under proper and effective supervision.

The following has been identified by the Federal Poultry Inspection Service as the standard handling procedure for making an adequate post-mortem inspection:

*A.* Right hand operation.

(1) Grasp one leg, run hand down leg to determine bone disease.

(2) Open body cavity to view internal surfaces.

(3) Turn body to view outside of bird (including head) for disease, abnormalities, and dressing imperfections.

*B.* Left hand operation.

(1) Place hand over liver to feel for consistency, texture, and lesions, viewing simultaneously.

(2) Slip fingers around liver and grasp the spleen between thumb and finger, rolling spleen to determine texture and presence of abnormal condition. In case of fryers and broilers it is not necessary to roll spleen. Simultaneously view other viscera while checking spleen.

In connection with the occurrence of infectious synovitis, it is necessary that hocks be cut as part of the preparation for inspection in order that the tell-tale exudates in the tendon sheaths and joint capsules may be detected. The hocks are cut into or the feet removed just before the inspection and in all cases after the carcasses have passed the last washer unit. Washing the carcasses after cutting of hocks would, of course, interfere with the inspection.

It is required that the head remain on the carcass until after completion of the post-mortem inspection. While every head need not be palpated or otherwise handled by the inspector, it is essential that he see the head as part of his total post-mortem examination. The condition of the head may be the determining factor in the inspector's decision with respect to the disposal of the carcass.

When evaluating the appearance and condition of the skin in connection with the post-mortem findings, the inspector considers the degree of scalding employed in the production line. When so-called semi-scald is used, normal variations in the color and consistency of the skin can be readily differentiated from those resulting from a pathological condition. When, however, higher temperatures are used in scalding the carcass, the result may be a removal of the epidermal layer of the skin with a resulting almost uniformly white appearance of the dressed carcass regardless of its condition.

**Pathology.**—The various abnormal and pathological conditions affecting poultry are discussed only briefly to cover the salient features of each and to develop their post-mortem significance in terms of fitness for food of an affected carcass. More complete discussion of the various abnormal and diseased processes can be obtained from texts on veterinary bacteriology, pathology, and parasitology.

**Avian Leukosis Complex.**—This designation is given to a group of neoplastic diseases resulting from an autonomous proliferation of the essential blood-forming cells.

**Erythroblastosis.**—This disease is of comparatively rare, sporadic occurrence under usual conditions. It affects all standard breeds and occurs primarily after the age of six months.

*Etiology and Pathogenesis.*—Transmissible strains of fowl leukosis have been identified with the disease. Erythroblastosis is regarded as occurring in a leukemic state, sometimes there is an accompanying anemia. Hematological studies show immature erythrocytes in the blood.

*Lesions.*—Typically, there is a diffuse enlargement of the liver and kidney as well as the spleen which is associated with a cherry-red discoloration. Tissues otherwise appear pale and there are frequently petechial hemorrhages in the mucosa of the small intestine and in the subcutaneous tissue. The bone marrow may show hemorrhagic hyperplasia of a "currant-jelly-like" consistency. By contrast, in anemic cases with no extramedullary hematopoiesis, the hyperplasia of the visceral organs and the bone marrow is absent with atrophy of the spleen.

*Post-mortem Significance.*—Carcasses of poultry affected with erythroblastosis are unfit for food.

**Granuloblastosis.**—This is the granuloblastic form of transmissible fowl leukosis with immature granular leukocytes predominating in blood studies. There is a tendency for granuloblastosis and erythroblastosis to occur in a mixed form. Therefore, available knowledge on these conditions is much the same.

*Etiology and Pathogenesis.*—This condition is also caused by one of the strains of the transmissible agents of fowl leukosis. There is little essential difference between granuloblastosis and erythroblastosis, except that the former is believed to occur in a later stage, while erythroblastosis is more common in the earlier stages of the disease.

*Lesions.*—Anatomic changes described under erythroblastosis are also identified with granuloblastosis. A distinction has been recognized, however, in that granuloblastosis has a tendency to produce grayish mottling of the enlarged parenchymatous organs and the bone marrow appears pale or pink and diffluent.

*Post-mortem Significance.*—As this disease is characterized by neoplastic cells in the blood, the diseased carcasses are unfit for food.

**Visceral Lymphomatosis.**—This condition represents the most common type of avian neoplasm under conditions of modern intensive poultry production. There are, however, other diseases capable of forming tumor-like nodules in the visceral organs as, for example, tuberculosis and myelocytomatosis.

*Etiology and Pathogenesis.*—The disease results from the neoplastic proliferation of the lymphocytes which form massive tumors in the visceral organs, thus, the name visceral lymphomatosis. When the neoplastic

FIG. 42.—Visceral Lymphomatosis liver nodular type, chicken. (Photo by Dr. Graydon S. McKee).

lymphocytes accumulate in the nerves, the designation neural lymphomatosis is applicable. Likewise, neoplastic lymphocyte accumulations in the iris is ocular lymphomatosis. In the average flock visceral lymphomatosis occurs parallel with the neural and ocular forms. However, the visceral form probably occurs somewhat later than the nerve or eye type. Probably no other disease of birds presents a greater variety of gross pathologic pictures than visceral lymphomatosis. The condition may be of long standing or the clinical course may be quite short in that seemingly healthy birds succumb within a few days.

*Lesions.*—Two types of lesions are found, one being white nodular masses of lymphocytes and two, the general enlargement of organs by diffuse

infiltration of the lymphocytes. The large abdominal glands such as the liver and kidney are principally affected. There is no organ of the body including the skin which is not involved at times. The spleen is characteristically enlarged, in most cases up to three times the normal size. The spleen is usually grayish-brown in color and the liver is characterized by a grayish and granular surface in the diffuse involvement. The kidneys present a diffuse, grayish enlargement. Though visceral *lymphomatosis* is usually a disease of older birds, it is sometimes found in birds of broiler age.

FIG. 43.—Neural lymphomatosis—note enlarged nerve trunks and ganglion, chicken thorax. (Photo by Dr. Graydon S. McKee).

*Post-mortem Significance.*—Carcasses affected with visceral lymphomatosis are unfit for food.

**Neural Lymphomatosis.**—This disease is widespread and occurs in every major poultry producing country. Under commercial conditions the disease often makes its appearance when the birds are first turned out on range; then; after a period of quiescence, the disease resumes its course in the visceral form.

*Etiology and Pathogenesis.*—This condition is also identified with the avian leukosis complex. It attacks young birds primarily between two and five months of age. It is characterized by an asymmetric progressive paresis

of the leg, wing, or neck, the paresis being either spastic or flaccid in character.

*Lesions.*—The disease is characterized by localized or occasionally diffuse, grayish soft swellings of peripheral nerve trunks. Nerve plexuses stand out prominently when affected. In uncomplicated cases the visceral organs appear normal. Fetid crop contents often reveal neural lymphomatosis on post-mortem examination.

*Post-mortem Significance.*—Carcasses affected with this condition are unfit for food.

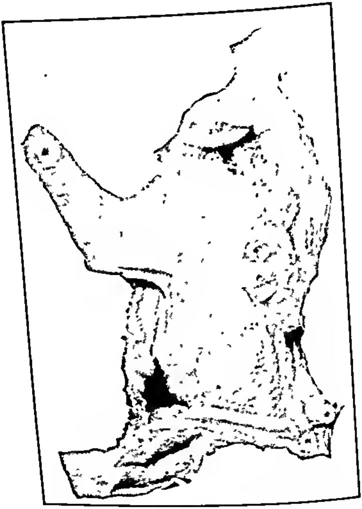

Fig. 44.—Osteopetrosis chicken (Photo by Dr. Graydon S McKee).

**Osteopetrotic Lymphomatosis.**—This is sometimes called thick-leg diseas and also marble-bone. As compared with other manifestations of the avia leukosis complex, the occurrence of osteopetrotic lymphomatosis is rar The condition often escapes detection until the birds are dressed. Fiel cases are sporadic in nature, though occasionally a high incidence is see in some flocks of young birds.

*Etiology and Pathogenesis.*—While this condition is frequently identifi with the avian leukosis complex, blood cells are not involved in this ne

plastic disease. It has been included with diseases of the avian leukosis complex because being a neoplastic disease it was often transmitted in experiments with the diseases of the complex. The diaphysis is primarily affected and is always bilateral. The intensity varies from exostosis-like cortical thickening to massive asymmetrical involvement that tends to obliterate the marrow cavity. Visceral pathology is absent unless complicated by visceral lymphomatosis.

*Lesions.*—In early cases leg bones show abnormal convexities or irregular thickenings in the diaphyseal or metaphyseal regions. In advanced cases characteristic boot-like thickenings of the shanks occur. Involvement almost always includes all of the long bones while the osseous components of the pelvis, shoulder girdle, and spine are rarely involved. The phalanges and skull bones appear to be resistant to the condition.

*Post-mortem Significance.*—Carcasses affected with osteopetrotic lymphomatosis are unfit for food.

**Tumors.**—The most common tumors found in birds not associated with the avain leukosis complex are the so-called carcino-sarcoma. This is a seeding tumor that often spreads by contact throughout the abdominal tissues particularly the peritoneum. Embryonal nephromas are commonly found in some types of broilers. Most all of the rarer neoplasms found in mammals are occasionally found in birds.

*Post-mortem Significance.*—Carcasses of birds affected with tumors are unfit for food if there is evidence of metastasis or if there is systemic effect as a result of the size, position, or nature of the tumor. When a benign tumor can be completely removed, the bird so affected is fit for food.

**Respiratory Disease Complex.**—Within the recent past there has become a general realization that the respiratory diseases of chickens in North America are so widespread that frequently more than one disease is present in any given disease outbreak. The complexity of this problem can be best understood when one realizes that the chronic respiratory disease believed to be caused by a pleuropneumonia-like organism cannot in laboratory infections demonstrate its entire pathological course as seen in a field outbreak.

Apparently other disease agents trigger latent infections or increase pathogenicity in the respiratory disease picture as it is usually encountered in commercial flock outbreaks. The diseases of the respiratory disease complex include such virus diseases as Newcastle disease, infectious laryngotracheitis, and infectious bronchitis, and such bacterial diseases as infectious coryza and the pleuropneumonia-like organism disease, chronic respiratory disease. Some investigators would also include some of the diseases caused by the paratyphoid organisms and ornithosis.

The diseases of the respiratory disease complex are described here as they occur in single infections. Multiple infections usually show similar lesions but are compounded by a synergistic effect of the two or more pathologic agents.

**Newcastle Disease.**—This condition is also called avian pneumoencephalitis. It is a disease of world-wide distribution and primarily affects fowl. A generally lower mortality is experienced with this disease in fowl in this country by contrast with other parts of the world. The disease is trans-

missible to man, occurring usually as a conjunctivitis. There is some evidence, however, that the disease is capable of causing systemic involvement in man. But it has been observed that the high prevalence of the disease in poultry as compared with the scarcity and mildness of reports in man indicates little cause for alarm.

*Etiology and Pathogenesis.*—This is a virus disease affecting the respiratory tract principally. Birds of all ages and breeds are susceptible although generally less so with advancement to maturity. Congenital immunity is also a modifying factor affecting susceptibility but only during the first few weeks of life.

*Lesions.*—A slight inflammation of the trachea and bronchi, with mild exudation, is commonly present. Cloudiness and yellowish thickening of the air sacs may be a prominent feature. Hemorrhages of the mucous membrane of the proventriculous have been seen in the more acute form. A small, pale spleen has been described as characteristic of the disease in the United States.

*Post-mortem Significance.*—Carcasses of poultry affected with Newcastle disease in a progressive stage or showing a general systemic disturbance should be condemned. When the lesions are localized and of such character and extent that there is no systemic disturbance, the affected parts only are condemned.

**Chronic Respiratory Disease.**—This is one of the most important diseases of birds in the United States from a food inspection standpoint. It is widespread particularly in broiler producing areas. Though mortality may not be high, lesions persist which interfere with normal growth, and these lesions affect the wholesomeness of the carcass long after the acute stage of the disease has passed. The disease as it occurs in the field is more severe than that produced in the laboratory. This is explained by the observation that field cases are accompanied by at least one of the other diseases of the respiratory disease complex.

*Etiology and Pathogenesis.*—Chronic respiratory disease is believed to be caused by a very small organism similar to the one causing contagious pleuropneumonia of cattle. It is therefore called the pleuropneumonia-like organism. Young birds are commonly affected though the disease may persist for a long time. The infection produces inflammatory changes in the paranasal sinus, trachea, lung, air sac, pericardium, and the serous surface of the heart.

*Lesions.*—Mucosal thickening, mucosal hemorrhage, and exudation of the paranasal sinus and trachea are observed. There may also be lymphofollicular reaction in the trachea. Bronchial thickening, exudation, and granuloma formation in the lung is accompanied with pneumonia in some cases. There may be exudation and lymphofollicular reaction of the air sac. Also observed is exudation of the pericardium and the serous surface of the liver.

A frothy, turbid exudate is frequently observed in the air-sac diverticula related to the shoulder joints. The yellow exudate that coats the thickened air-sac membranes varies from viscid to cheesy in consistency.

*Post-mortem Significance.* The carcass is unfit for food where there is systemic involvement. When localized, the affected organ or part of carcass is condemned before passing the carcass for food.

**Infectious Laryngotracheitis.**—Chickens are the usual host for this disease but pheasants are also susceptible. Other species of birds are resistant to the disease. Infectious laryngotracheitis is an acute, contagious respiratory disease having a distinct host specificity for chickens.

*Etiology and Pathogenesis.*—The disease is caused by a filtrable virus called tarpeia avium. The respiratory tract is the natural route of infection.

FIG. 45.—Air in subcutaneous tissue following rupture of air sack in post axillary region, chronic respiratory disease. (*Photo by Dr. Graydon S. McKee*).

*Lesions.*—The head may be cyanotic. The mucous membrane of the trachea and larynx may be covered with a film of bright blood-stained exudate. A yellowish caseous exudate with little or no blood may cover the mucosa in some cases.

*Post-mortem Significance.*—Carcasses showing the disease in a progressive stage or showing systemic involvement are unfit for food. When the con-

dition is localized and not accompanied with systemic change the carcass may be passed for food after removal of affected parts.

**Infectious Bronchitis.**—As a disease of baby chicks, infectious bronchitis may often produce high mortality and 100 percent morbidity. Uncomplicated infection in older birds, particularly pullets, results in a precipitous drop in egg production which persists for several weeks, frequently resulting in permanent reduction. From a meat hygiene standpoint the disease is important because it often complicates chronic respiratory disease infection increasing its pathogenicity.

*Etiology and Pathogenesis.*—This is a virus disease affecting chickens only. There is little apparent gross pathology in mature birds.

*Lesions.*—Birds of market age do not show significant pathological changes when affected with this disease in an uncomplicated state.

*Post-mortem Significance.*—In its uncomplicated state, this disease has little or no post-mortem significance since its recognition on post-mortem inspection is unlikely.

**Infectious Coryza.**—This is a respiratory disease of chickens. Infectious coryza occurs most frequently in the fall and winter. In summer months it may be less severe with a shorter duration.

*Etiology and Pathogenesis.*—Infectious coryza is caused by *hemophilus gallinarum*. The course of the disease varies considerably depending on the virulence of the organism involved. Factors such as secondary bacterial invaders, poor housing, parasitism, and inadequate nutrition influence the course of the disease. The organism produces an acute catarrhal inflammation of the mucous membranes of the nasal passages and sinuses.

*Lesions.*—The catarrhal inflammation of the mucous membranes of the nasal passages and sinuses frequently extends to involve catarrbal conjunctivitis and subcutaneous edema of the face and wattles. Occasionally the trachea and bronchi are involved. In chronic cases the inflammatory process is accompanied by caseous exudate in the sinuses, nasal passages, and conjunctival sacs as the disease is complicated with other bacteria

*Post-mortem Significance.*—Carcasses showing systemic involvement are unfit for food. When the condition is localized the affected portions are removed and the carcass is passed for food.

**Botulism.**—This condition affects man and domestic animals as well as chickens and other domestic birds. It is one of the food poisonings produced by bacterial toxins.

*Etiology and Pathogenesis.*—Botulism results from ingestion of toxins produced as the product of growth of *clostridium botulinum* on food eaten by the bird. The organism is widely dispersed in the soil and occurs on food as a contaminant. The food becomes dangerous, however, only after the organism has grown and produced toxin. *Clostridium botulinum* is an obligate anærobic spore-forming rod. Of its five sub-types only type A and type C commonly cause botulism in domestic birds. The toxin attacks nerve tissue with resulting paralysis and intoxication.

*Lesions.*—Gross changes are usually lacking and there are few lesions seen on post-mortem examination. Portions of the intestine may be dilated or distended with a slight catarrhal enteritis. Small hemorrhagic

areas may sometimes be seen in the intestinal mucosa. The contents of the crop become fetid and often contain maggots.

*Post-mortem Significance.*—It is important in this condition that post-mortem findings be correlated with the report of symptoms observed on ante-mortem inspection. Birds showing symptoms of botulism are detected on ante-mortem inspection and condemned. Carcasses of birds affected with botulism are unfit for food.

Fig. 46.—Fowl cholera liver showing swelling and widespread necrotic foci. (Photo by Dr. Graydon S. McKee).

**Fowl Cholera.**—This is a septicemia of birds. Fowl cholera occurs enzootically and sporadically in most of the temperate and warm regions. It is a contagious disease affecting practically all classes of poultry. It causes heavy losses in some outbreaks, while in others the losses may be nominal. In the United States the disease is more or less seasonal, being most common in wet or cold weather.

*Etiology and Pathogenesis.*—The causative agent of fowl cholera is *pasteurella multocida*. The disease is usually septicemic in nature. The infection is given off by diseased birds in the body wastes.

*Lesions.*—The acute disease is characterized by petechial hemorrhages of the mucous membranes. The lungs and intestines are usually affected. Petechia may also appear on the serous surfaces. There may be a cheesy exudate in the peritoneal cavity with parenchymatous hepatitis. Dehydration of tissues and salmon-colored breast muscles are common in turkeys. The localized form may show yellow exudate occurring in the internal ear or in the bones at the base of the brain. There may also be catarrhal or roup-like exudate in the nares. There may be edema of the wattles. In the arthritic form there is a yellow exudate deposited in the tendon sheaths. A yellow exudate sometimes surrounds the ovary.

*Post-mortem Significance.*—Carcasses affected with fowl cholera in a progressive stage or showing evidence of general systemic disturbance are unfit for food. When the condition is localized the carcass may be passed after removal of the affected parts.

**Ornithosis and Psittacosis.**—This disease affects many species of birds being identified primarily with the psittacine species, but of significance here are infections of domestic fowl including more particularly turkeys, though chickens and ducks may also be infected. Although it does manifest itself as an apparent infection, it is more frequently inapparent. The disease is transmissible to man ranging from slight to fatal manifestations.

*Etiology and Pathogenesis.*—It is usually regarded as a virus disease, but the infective agent is sometimes characterized as a form intermediate between rickettsiae and true viruses. The infective agent invades and destroys reticulo-endothelial cells particularly those of the spleen.

*Lesions.*—Inflammation of the serosal surfaces with fibrinous exudation is consistently observed. Air sacs are inflamed and thickened, and sometimes contain masses of cheesy exudate. Mesentery and serosal surfaces of the intestines also are injected and inflamed in many birds. The abdominal cavity in some birds contains fluid and fibrin deposits in varying amounts. Livers are slightly enlarged and off color, and in many birds the surface is covered with whitish fibrinous films. The pericardium almost always shows evidence of inflammation with fibrinous exudation and epicardial adhesions. The pericardial cavity of some birds contains exudate and fibrinous flakes. Myocarditis is evident, parts being soft, large, and flabby. Diffuse pneumonia is seen but pulmonary edema is noted more often.

*Post-mortem Significance.*—Carcasses showing active lesions of this disease are unfit for food.

**Listeriosis.**—Outbreaks of this condition in chickens have been recorded in many parts of the United States and England. The distribution of the infection in man and animals appears to be world-wide. Listeriosis occurs sporadically in man and is characterized by meningitis. Many other hosts are susceptible to spontaneous infection including the goat, sheep, cow, fox, guinea pig, and rabbit. The encephalitic form, however, which is characteristic of listeriosis in domestic mammals and man has not been observed in naturally affected chickens. In birds it manifests itself as a septicemia.

*Etiology and Pathogenesis.*—Listeriosis is caused by the bacterium *listeria monocytogenes.*

Listeria infection in chickens may often be associated with some other disease or debilitating process. Young chickens appear to be more susceptible to the disease than are adults although these, too, may succumb to the condition. In contrast to the domestic mammals in which listeria is often confined to the central nervous system, the organism can be isolated from the abdominal organs and from the heart blood of chickens.

*Lesions.*—The disease is characterized by massive necrosis of the myocardium, pericarditis, generalized edema, necrotic foci of the liver, and splenic hyperemia. A large amount of fluid may be present in the pericardial cavity.

*Post-mortem Significance.*—As usually encountered listeriosis is an acute systemic condition and such carcasses are condemned. In the case of a carcass from a bird that has recovered from the condition and which shows only localized conditions without systemic involvement, the affected parts are condemned.

**Salmonellosis.**—This refers to all infections with organisms of the genus *salmonella* including the two distinct poultry disease organisms *S. pullorum* and *S. gallinarum.* They all have potential pathogenicity for man. There have been numerous reports incriminating poultry or poultry products in outbreaks of salmonellosis in man. Investigators have found a great number of salmonella types, more than 60 in fowl. In fact, more types have been found in fowl than in any other species except man. All types are potentially pathogenic for man, animals, and fowl. Salmonella infection depends largely on age, number of organisms in exposure, and general resistance rather than on the type of salmonella organism. The young are particularly susceptible. Apparently given large enough dosage all salmonella organisms are pathogenic for man.

*Etiology and Pathogenesis.*—Salmonella organisms cause intestinal disorders in many animals including man. The infection sometimes follows a septicemic course. Salmonellosis in market age birds may assume two forms, (1) the acute or active disease which is a septicemia and (2) the carrier stage with moderate localized inflammatory lesions which do not produce clinical symptoms.

*Lesions.*—In the septicemic form, post-mortem findings include inflammation of the duodenum and hyperemia of the liver, kidneys, gall bladder, and myocardium. Excessive, straw-colored pericardial fluid may be present as well as caseous plugs in the cecum. Dehydration of the musculature can often be observed. In the carrier state localization of the salmonella organisms in the air sacs and articular surfaces as well as the gonads is not uncommon. From a meat hygiene standpoint, persistent foci of infection in the intestinal and the biliary mucosa spread the infection through the intestinal contents and the bile.

*Post-mortem Significance.*—Poultry carcasses affected with salmonellosis in the active stage are condemned.

**Pullorum Disease.**—Wherever poultry is raised, pullorum infection is likely to be found. It is world-wide in distribution. Since the last decade of the nineteenth century, this disease has resulted in the greatest financial losses to the poultry industry. The organism causing this disease is not as infective for man as some of the other salmonellas. However, experimental infections and field outbreaks in man are reported and give indication that

the organism may have been the cause of some cases of previously undiagnosed gastroenteritis in man.

*Etiology and Pathogenesis.*—Pullorum disease is a bacterial infection caused by the *salmonella pullorum*. This organism has many features in common with the other members of the salmonella group. The disease is highly fatal to chicks; older birds seldom show clinical symptoms but become carriers. Evidence of a carrier infection in birds is shown by ruptured, dirty, inflamed, or coagulated ova or degenerated or inflamed gonads. Such carrier birds may develop a generalized septicemia as a result of rough handling in the course of marketing with resultant rupture of the ova. The carcasses of these birds contain great numbers of the pathogenic organism.

*Lesions.*—The lesions of the septicemic type include hemorrhagic enteritis and punctate or petechial hemorrhages on the pericardium, pleura, proventriculus, mesentery, kidneys, lungs, liver, spleen, and other serous and mucous membranes. Cyanosis and dehydration of the musculature, fascia, and derma are also frequent evidences of septicemia. Necrosis, hyperemia, anemia, or inflammatory changes in the organs and parts of the carcass are common.

*Post-mortem Significance.*—Carcasses of poultry are condemned when extensively affected with pullorum disease, or showing systemic change connected with the disease. When the lesions are localized and there is no systemic disturbance, only the affected parts are condemned.

**Fowl Typhoid.**—This disease is widespread in the poultry-producing areas and on occasions has caused very heavy losses in both chickens and turkeys. Surveys show fowls of all ages and breeds to be susceptible. Outbreaks are sporadic, however, and the factors which influence the outbreaks are not completely recognized or understood. The salmonella organism that causes fowl typhoid in birds has on occasion been associated with gastroenteritis in man. The significance of this etiological relationship is sometimes difficult to determine. However, reports support a finding of dual pathogenicity.

*Etiology and Pathogenesis.*—The causative agent of fowl typhoid is *Salmonella gallinarum*. This organism bears a close relationship to *S. pullorum*. Fowl typhoid causes a general systemic disturbance in the affected birds. In the peracute cases, little or no gross tissue changes are observed. The ante-mortem inspection will eliminate the acutely sick birds. The condition also occurs in the subacute and chronic stages. In these stages, the characteristic lesions are identified on post-mortem examination.

*Lesions.*—The post-mortem examination shows anemia of the musculature, head parts, skin, and kidneys. The liver is hypertrophic, mahogany or greenish in color, friable, sometimes with necrotic foci distributed throughout. The spleen is markedly enlarged, congested, and frequently contains tiny grayish-white spots which are areas of necrosis. Grayish nodules and areas of degeneration may appear on the myocardium and the pericardial sac. Chronic infection of the gonads is a frequent finding in recovered birds which at times is very important in breeder turkeys as the disease is carried through the incubation period in the embryo.

*Post-mortem Significance.*—Carcasses of poultry are condemned when

affected with fowl typhoid in the progressive stage characterized by systemic involvement. When there is no systemic involvement and lesions are localized, only the affected parts are condemned.

**Tuberculosis.**—This condition is world-wide in its distribution in chickens. The disease exists in practically all of the United States, but it is much more prevalent in the north central states. The disease when present in adult birds represents in most instances a process that began months or even years before when the bird was young. Tuberculosis becomes more prevalent as the ages of the birds advance not because the younger birds are

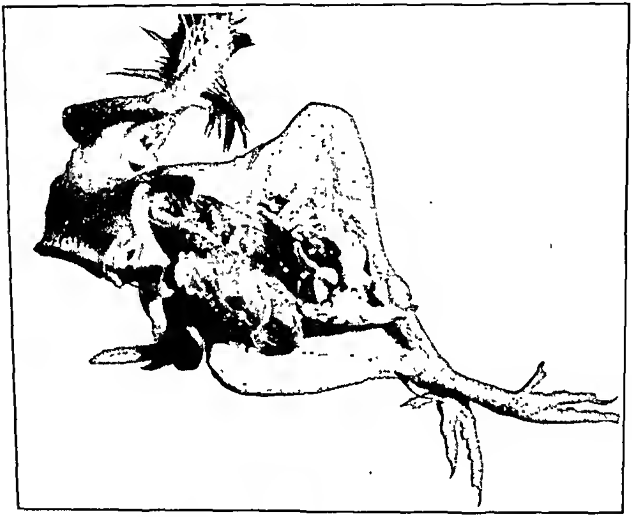

Fig. 47.—Tuberculosis, chicken. (Photo by Dr. Graydon S. McKee.)

more resistant to infection than the older birds, but because the older birds have been subjected to a longer period of exposure. Avian tuberculosis is transmissible to swine and sometimes other animals but only rarely to man. There have been a few confirmed cases, however, in which the organisms were identified in man.

*Etiology and Pathogenesis.*—Avian tuberculosis is caused by the acid-fast organism, *Mycobacterium tuberculosis* variety avium. The avian tubercule bacillus is not as exacting in its temperature requirements as are the human and the bovine forms of the organism. The avian form will grow at temperatures ranging from 25° to 45° C. with the most favorable tem-

perature being 39° and 40° C. The disease is characterized by an insidious chronicity. It induces in an infested bird a state of unthriftiness, decrease or stoppage of egg production and finally death. Apparently the disease does not produce a febrile state in chickens.

*Lesions.*—The liver, spleen, intestines, and bone marrow are most commonly involved. Tuberculosis infection in chickens is regarded as entering the system principally through the digestive tract. Involvement of the lung is usually less severe than of the liver or spleen. Avian tuberculosis is characterized by the occurrence of irregular grayish-yellow or grayish-white nodules of varying sizes in the involved organs and tissues. The nodules vary in size from those just barely discernible to a huge mass that may measure several centimeters in diameter. The number of lesions present also varies greatly. Calcification of the nodules occurs rarely if ever, this is a unique characteristic of the tuberculous lesion in fowl.

*Post-mortem Significance.*—Poultry carcasses affected with tuberculosis are condemned.

**Erysipelas.**—This is a septicemia occurring in turkeys, ducks, chickens, pigeons, pheasants, quail, and peacocks as well as birds in zoological gardens. The causative agent is the same as that producing swine erysipelas and erysipeloid infection in man. In addition to hogs and human beings, horses, cattle and sheep are also susceptible to the infection. Young turkeys and ducks are most commonly affected, and in some outbreaks heavy losses have occurred. The condition is usually acute or subacute in character. Cutaneous infections appear more common in man who appears to be relatively resistant to the infection entering the gastrointestinal tract.

*Etiology and Pathogenesis.*—*Erysipelothrix rhusiopathiæ*, a long, slender, gram-positive bacteria, is the causative agent. In birds the disease usually occurs as a septicemia which may be acute or subacute in character. Turkeys and ducks are quite susceptible to the disease and this susceptibility is increased by other infections, malnutrition or any condition which lowers the bird's vitality. Chickens do not appear to be as susceptible as turkeys and ducks. Pigeons are also susceptible; in fact, these birds are used routinely for diagnosis of swine erysipelas.

*Lesions.*—Petechial and punctate hemorrhages are present in the pectoral, thoracic and abdominal muscles, over the ribs, and occasionally in the region of the thigh. Hemorrhages may also involve the pericardium, epicardium, pleura, and peritoneum. Thick mucous is usually found in the nasal cavity. The liver is regularly involved being hypertrophic, engorged, and friable. Inflammation of the duodenum regularly occurs and in some cases the lower intestine is similarly involved. The lungs and kidneys may show congestion. The spleen is usually friable and congested. Swelling of the snood, when it is present, seems pathognomic. Cyanosis is usually present. Erysipeloid lesions may appear on the face.

*Post-mortem Significance.*—Carcasses of poultry affected with erysipelas are unfit for food.

**Pseudotuberculosis.**—This disease occurs in birds, animals, and man. In fowl, outbreaks have been reported chiefly in turkeys and rarely in ducks, pigeons, and chickens. In man it appears to be rare but highly fatal. The mode of transmission is not definitely known, but the organism is believed

to be widely distributed in nature and disseminated through infectious excretions of affected birds or rodents. Susceptible animals are attacked through the digestive tract.

*Etiology and Pathogenesis.*—The disease is caused by *pasteurella pseudotuberculosis.* It is characterized by an acute speticemia of short duration, followed by a chronic localized infection which gives rise to tuberculous lesions in various organs which are not as fibrous as those seen in the usual infection of avian tuberculosis. So-called daughter lesions are not a common finding in pseudotuberculosis infection.

*Lesions.*—Acute cases are characterized by hypertrophy of the spleen and hemorrhagic enteritis. Subacute or chronic cases show gross enlargement of the liver, spleen, kidneys, and lungs. Yellowish-white foci of the size of millet seed appear in these organs as well as in the breast muscle and mesentery. Ascites is often a feature of the disease.

*Post-mortem Significance.*—Carcasses of poultry affected with pseudotuberculosis are condemned.

**Fowl Pox.**—Fowl pox is a common affliction of the avian species and it has a long history. It is a widespread disease and is prevalent wherever poultry is raised. The greatest incident of infection is during the fall and winter months. It usually makes its occurrence in young stock at about the time they are housed in laying quarters.

*Etiology and Pathogenesis.*—Fowl pox is caused by a filtrable virus. The disease appears in both a cutaneous and a mucous membrane form. Depending on the virulence and pathogenicity of the strain of the virus involved, the fowl pox infection may be manifested in one of three ways or a combination of these. The involvement may be a localization of typical cutaneous pox lesions on the comb, wattles, and face, or localization of the infection in the mouth region with typical diphtheritic lesions, or localization of the infection in the nasal chambers with coryza-like symptoms.

*Lesions.*—The characteristic lesion of the cutaneous form of fowl pox is a local epithelial hyperplasia involving both epidermis and underlying feather follicles with the formation of nodules. The nodules first appear as small, whitish foci which rapidly increase in size and become yellowish in color as they develop. At this stage the bird is systemically sick with fever as evidenced by dehydration of the musculature. The lesions may coalesce with the larger lesions, becoming rough and gray or dark brown in color. The lesions later undergo a process of dessication and scab formation. This process is often modified by the invasion of bacteria which produce suppurative or necrotic processes.

In the diphtheritic form, the eruptions on the mucous membrane are white, opaque, slightly elevated nodules. These increase in size often coalescing to become yellowish, cheesy, and necrotic with the appearance of a pseudomembrane. At this point cyanosis and other evidence of asphyxiation are seen. Secondary infection also frequently complicates this process. The inflammatory process may extend from the mouth region into the sinuses resulting in tumor-like swelling of the head extending into the pharynx.

*Post-mortem Significance.*—Carcasses affected with fowl pox accompanied with systemic involvement or bearing progressive lesions are unfit for food.

Carcasses of birds that have recovered from the disease are passed for food following removal of any persistent cutaneous scabs, if present.

**Coccidiosis.**—This disease is widespread and occurs in practically all kinds of birds. As a group, the coccidioses of chickens are of more economic importance than those of any other domesticated bird. The various species of coccidia are reasonably host-specific. Turkeys, ducks, and guinea fowl suffer less than do chickens from coccidial infection, although under certain conditions the infection may be serious in these birds. Renal coccidiosis may be serious in geese.

*Etiology and Pathogenesis.*—There are eight species of coccidia of the genus *eimeria* that occur naturally in chickens. The minimal effect of the invasion is the destruction of a certain number of easily replaced epithelial cells and mild intestinal inflammation but in the more severe types there occur serious cell destruction, inflammation, and sometimes hemorrhage.

*Post-mortem Significance.*—Carcasses of birds affected with acute coccidiosis and those carcasses showing systemic change are unfit for food.

**Parasites Generally.**—A great variety of parasites affect birds. For the purpose of post-mortem poultry inspection, the disposition of a poultry carcass depends more on kind and degree of involvement than on an identification of the specific parasite. Affected organs and parts are unfit for food, for example, gizzards infected by gizzard worms. Feet and shanks affected by scaly-leg mites are discarded. When lesions in the carcass are extensive or there is systemic involvement, the entire carcass is unfit for food. Otherwise, the carcass is passed for food after elimination and condemnation of affected parts. The lesions of air-sac mites and connective tissue mites which are sometimes found in older birds are judged in the same way.

**Aspergillosis.**—Nearly all species of birds may be affected by this condition, however, the incidence of the disease is not great. It has been observed in many birds and mammals including man.

*Etiology and Pathogenesis.*—The disease is produced by an aspergilli fungus identified as *aspergillus fumigatus fresenius.* The organism is widespread in straw and hay, and infection of young birds from the litter is the usual source of infection rather than from bird to bird. Infection of the lungs occurs following inhalation of spores.

*Lesions.*—The lungs are more frequently involved. Pulmonary lesions vary from miliary nodules to large nodules. There may be localized hepatization. Mycelial masses may be present in the air passages and bronchi. There may also be generalized involvement of the air sacs. Small, yellow-colored nodules of a cartilagenous consistency may be found in the lungs, the thorax, and the abdominal air sacs.

*Post-mortem Significance.*—Carcasses affected with this condition are unfit for food if there is systemic change.

**Favus.**—This disease occurs only infrequently in the United States. It is a chronic dermatomycosis affecting chickens, occasionally turkeys, and some other birds, animals, and man. The disease is reported to be quite common in France.

*Etiology and Pathogenesis.*—The causative agent in fowl is the fungus *achorion gallinae.* The disease in domestic poultry usually involves the

comb, wattles, and unfeathered skin around the eyes, sometimes extending to the feathered skin of the neck, back, and other parts of the body.

*Lesions.*—Minute mold-like, greyish-white scutula characterize the infection. These coalesce to cover the comb and wattles. When the feathered portions of the skin are affected, the feathers become surrounded by a thick, scaly, scutulum and become loose in the follicles. .

*Post-mortem Significance.*—When the condition is progressive and the carcass shows systemic change, the carcass is unfit for food. Otherwise, the affected portions are removed and the unaffected portion is passed for food.

**Thrush.**—This mycosis of the digestive tract probably occurs rather frequently in poultry but it is only occasionally that serious outbreaks affect birds. The fungus that causes this condition in poultry also affects animals and man.

*Etiology and Pathogenesis.*—The yeast-like fungus *Monilia albicans* is the cause of this condition. The crop is most commonly affected, but there may also be lesions in the mouth, esophagus, and proventriculus. A focal liver necrosis may be associated with this condition in turkeys.

*Lesions.*—The crop shows thickening of the mucosa with whitish, circular, raised, ulcerous formations. There may be extensive disruption of the stratified epithelium with walled-off ulcers or extensive diphtheritic membrane. The lesions are characterized by the absence of inflammatory reaction in many cases.

*Post-mortem Significance.*—Carcasses affected with this condition to the extent that there is systemic change are unfit for food.

**Localized Inflammatory Processes, Bruises, and Contamination.**—Such conditions result from a great variety of causes. All tissues so affected are unfit for food. Carcasses are passed for food after complete removal is accomplished of affected parts and such removal is done without contamination of the portion that is passed for food. Such benign, non-specific conditions as paralysis of the crop or pendulant crop should be judged in the same manner.

# Chapter 5

## TRICHINÆ

**General.**—Trichinae present a special meat hygiene problem principally because examinations made macroscopically of swine carcasses do not detect the condition and trichinosis is a serious affliction of man. The infective parasite is microscopic and its presence in pork muscle tissue does not produce a condition which can be seen by the unaided eye. Trichinosis affecting the muscle tissue of swine is caused by the larval form of the roundworm parasite *Trichinella spiralis*. When an individual consumes pork containing viable larvæ, the life cycle of the parasite will be completed in the new host resulting in infestation of the muscle tissue of the new host by its larvæ. The infestation may result in a wide range of clinical symptoms. These symptoms may be slight and barely noticeable, however, the infestation may cause severe, excruciating pain, prolonged illness, and death.

The prohibition contained in the Talmud against eating pork is probably an early recognition of the occurrence of illness traceable to eating raw pork. If that is the case, it is the earliest clue to the existence of trichinosis.

Recognition of the trichina parasite in modern times dates from 1835 when it was discovered in England by Paget and described by Owen on the basis of Paget's discovery. The first report in the United States was made around 1842 by Bowditch who found the parasite in performing necropsies on human bodies. Leidy's discoveries in 1847 in connection with his work on hogs stimulated in the United States work on diagnosis of trichinosis and resulted in the first nation-wide survey of the incidence of the trichina parasite in man. In 1880, outbreaks of trichinosis in Germany received nation-wide attention in that country. This led to the exclusion, by Germany, of importations of pork from the United States. The resulting Federal legislation in the United States was the first of a series of enactments by the Congress which led up to the passage of the Federal Meat Inspection Act of 1906.

**Trichinella spiralis.**—This parasite is a roundworm, the adult form of which occurs in the small intestine of man, swine, rat, and many other mammals. The male is 1.4 to 1.6 mm. long and the female is 3 to 4 mm. long. The body is slender and the esophageal portion is only slightly narrower than the posterior portion. The male has a pair of lateral flaps on either side of the cloacal opening at the posterior end with two pairs of papillæ between the flaps. The vulva is situated near the middle of the esophageal region in the female. The eggs measure 40 by 30 microns and contain fully developed embryos. The larvæ measure from 5 to 6 microns in diameter and from 80 to 120 microns in length when they are

deposited by the female parasite, and grow to 0.8 to 1 mm. in length after they reach their final location which is preferably in skeletal muscle.

**Trichinosis.**—Within a few hours after the meat containing viable larvæ is ingested, the parasites are liberated from their cysts and penetrate the mucosa of the small intestine. Here they may produce symptoms of enteritis in the human. In about three days these larvæ develop into sexually mature adult parasites of the intestinal form. After copulation takes place the male dies and the gravid female penetrates deeply into the mucosa. Here the larvæ are deposited in the mucosa or in the central

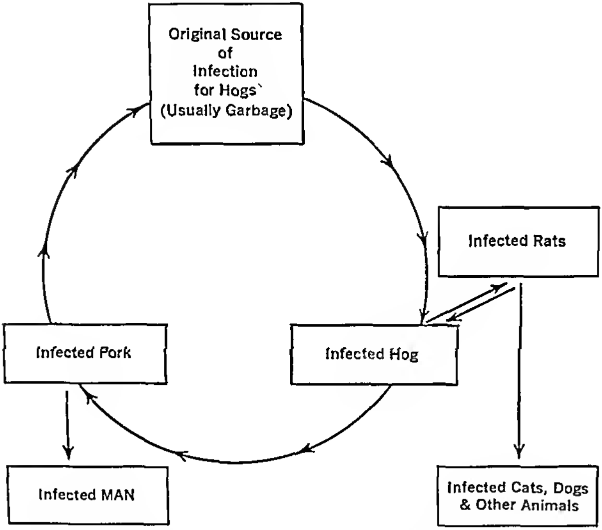


FIG. 48.—Diagram illustrating the common method of exposures to trichinosis in the Continental United States. (Faust, Human Helminthology.)

lacteals. The females live for about six weeks, each giving birth to more than 1,000 larvæ. In animals, the larvae are deposited four or five days after the gravid female has entered the mucosa. This is believed to take about seven days in man.

The larvæ pass through the intestinal lymphatics on to the thoracic duct. From here they enter the general circulation and are distributed throughout the body. They prefer to locate in skeletal muscle, especially the muscle of the diaphragm, tongue, larynx, muscles of mastication and intercostal muscles. These larvæ may, however, invade the heart, the central nervous

system, and the lungs. The time lapsing between infection and muscle penetration by the larvæ is variable. Larvæ may begin to reach the muscles eight days after ingestion of the infested material but, generally this takes fifteen days after infection. After they reach the muscle tissue

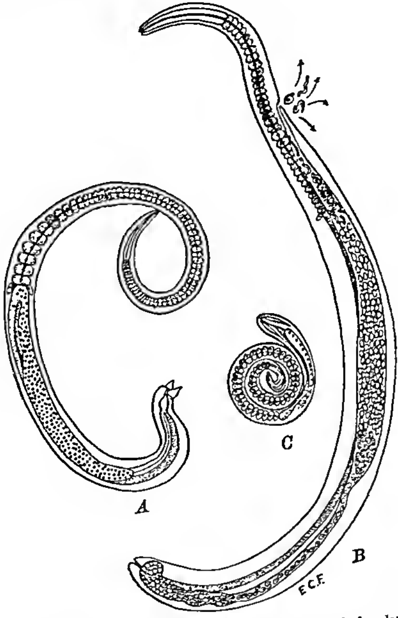


FIG. 49.—Trichinella spiralis. *A*, Adult male × 90; *B*, adult female; *C*, larva × 660. (From Faust. *A* and *B* after Yorke and Maplestone's Nematode Parasites of Vertebrates, courtesy of J. and A Churchill, Ltd. *C*, Adapted from Stäubli.)

they penetrate the sarcolemma of the muscle fibers where they grow rapidly. Within ten days to two weeks, they reach their full growth during which time they become spirally coiled. When they have attained their full growth, they have reached the infective stage. In three to six weeks a membranous capsule begins to form around the worm. The cyst so

formed is ovoid and lemon-shaped, and may contain from 1 to 5 coiled larvæ. The life of the larvæ is quite variable since they remain alive in some cases for several years. Usually, calcification of the cyst wall begins to take place in less than a year, although several years may be required for complete calcification. When the larvæ die, they too may become calcified, or they may be absorbed.

The presence of larvæ in pork muscle tissue usually has little effect on the surrounding muscle fibers. This circumstance along with the microscopic size of the parasite precludes detection of the condition in pork muscle tissue by macroscopic examination.

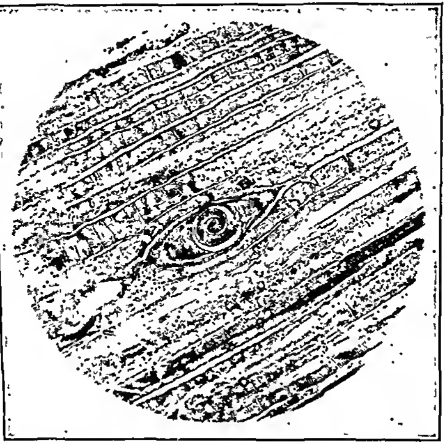

FIG. 50.—Encysted T. spiralis in lean pork meat. (Aldridge, Amer. Jour. Med. Sci.)

In man, the reaction of the muscle tissue to the larvæ is characterized by many degenerative changes. This is accompanied with hyperemia, proliferation of endothelial cells, edema, and an inflammatory cell infiltration of neutrophilic polymorphonuclear leukocytes, lymphocytes, and tissue histiocytes and occasionally plasma cells. The muscle tenderness and soreness are thought to bear a direct relation to the severity of this interstitial myositis.

**Clinical.**—The two quotations that follow are taken from the 1941 and 1942 Reports of the New York State Trichinosis Commission.[1] They describe the clinical picture of trichinosis as it is seen in man.

[1] The New York State Trichinosis Commission was created by an enactment of the New York State Legislature in 1940 entitled "*An Act creating a temporary State Commission to study the problem of trichinosis and other diseases contracted by eating affected meat and making an appropriation for the expenses of such commission.*" The life of the Commission extended for the two years 1941 and 1942.

"The symptoms of trichinosis are very diverse and may affect any system of the body with the possible exception of the reproductive system. The intensity of the disease is extremely variable and is dependent for the most part on the degree of infection and the resistance of the individual. Thus, one may encounter all gradations of symptoms ranging from a mild, almost sub-clinical syndrome to those characterizing a severe, fulminating fatal infection. Because of this, it is not surprising that all cases of the disease are not readily recognized and that the symptoms are sometimes confused with those of half a hundred other diseases which they may simulate.

"The difficulties in diagnosis are well exemplified by two outbreaks investigated by Dr. F. J. Brady and J. Bozicevich of our staff[1] during the past year (1941). In one of these outbreaks the diagnoses were progressively influenza, poliomyelitis, and lymphocytic choriomeningitis, diagnoses which appeared justified on clinical grounds because of the close similarity of the symptoms exhibited by some of the patients to those of these diseases. The condition was finally recognized as trichinosis by the county health officer who had recently returned from a year's postgraduate work during which he had attended lectures and demonstrations on this disease. The cases in the other outbreak were variously diagnosed by the family physician and four consulting physicians as colitis, appendicitis, and la grippe. One of the patients who was hospitalized was suspected of having bacillary dysentery because of the severe diarrhea. Here again the symptoms were quite similar to those of the conditions mentioned and naturally led to the diagnoses in question.

"In a paper describing 19 clinical cases of trichinosis treated at the Mayo Clinic, Wyreos, Tillisch and Magath noted the original diagnosis which was made in each case by either the referring physician or the physician who first saw the patient in the clinic. Trichinosis was diagnosed six times, nephritis twice, indeterminate diarrhea twice, unstated infectious processes twice, and conjunctivitis, sinusitis, traumatic headache, secondary anemia, encephalitis, neurosis and migraine once each.

**Incidence.**—*Swine.*—Of the many mammalian hosts of the trichinella spiralis, only the domestic hog is of importance from the standpoint of human health. Many investigations support the finding that swine which are not fed uncooked garbage have a very low incidence of the parasite. In this class of swine the infection furthermore is usually slight. Garbage-fed swine on the other hand have revealed an infection more than ten-fold that of the swine which have not been fed garbage. Also, a larger proportion of extensive infections is found in garbage-fed swine.

The report contained in the following quotation taken from the Annual Reports of Department of Agriculture for 1952 gives findings that are characteristic of work performed by other investigators in the field.

"*Trichinae in farm-raised and garbage-fed hogs.*—The present-day frequency and degree of infection of farm-raised hogs with trichinae is much lower than it was twelve to fifteen years ago. Garbage-fed hogs, on the other hand, have about the same incidence and intensity of infection with these disease-producing parasites that they had in former years. As a matter of fact, in farm-raised hogs trichinae were so few that they could rarely be discovered even by microscopic inspection. In garbage-fed hogs, on the other hand, which came from the outskirts of large, eastern cities, trichinae were found in a rather large percentage of the hogs examined, and in fairly large numbers. This made their detection, with the aid of the

[1] This was taken from the part of the 1942 Report contributed by Dr. Willard H. Wright, Chief, Division of Zoology, National Institute of Health, U. S. Public Health Service

microscope, possible in many, but not all, cases. These facts were discovered in a survey carried out, in cooperation with the Meat Inspection Division."

Over 3,000 diaphragms from pigs originating in Illinois, Indiana, Iowa, Kentucky, Missouri, Ohio, and Nebraska were collected at random at meat-packing establishments over a period of about three years. The pillars of the diaphragm which are a preferred location of trichinae, were digested in all cases in a solution of pepsin acidified with hydrochloric acid, and the sediment examined for trichinae. In most instances direct microscopic examinations of small pieces of diaphragm muscle tissue also were made. Only 19 out of the 3,031 samples (0.16 per cent) examined by artificial digestion were found to contain trichinae; the maximum number of parasites in any one sample was between seven and eight per gram of muscle, the remaining samples containing from five trichinae per 1,000 grams (about 2 pounds) to two per gram. Trichinae were not found in any sample examined by direct microscopic inspection.

In similar study of the diaphragms of 1,328 garbage-fed hogs, collected in Boston, Philadelphia, and New York, 149 (11.2 per cent) contained trichinae when examined by the digestion technique. Moreover, trichinae were found by direct microscopic inspection in 64 (4.8 per cent) of the samples. Actual counts of trichinae in these samples revealed 100 to over 2,700 of the parasites per gram of muscle tissue.

Investigations conducted by Zimmerman, Schwarte, and Biester revealed an extremely low incidence of trichinae infection in Iowa swine examined during 1943-1955. Only one of the 2,184 pigs examined was found to be positive for the parasite. Similarly, work performed by Himsey and Adams revealed one trichinae-infection in 1,000 swine diaphragms obtained from swine slaughtered in the Louisville, Kentucky, market.

*Wildlife.*—The occurrence of the trichinae parasite in rats and wildlife has long been recognized, but no relationship has been specifically identified between that infection and the trichinae infection of swine. Two possible modes of transmission of the parasite from wildlife to swine have been explored. They are (1) fecal transmission and (2) direct transmission when the swine eat the infected carcass.

The tests conducted to determine the probabilities of fecal transmission either of larval or adult trichinae from wildlife to swine have been negative in some cases and positive in others. Fecal transmission must be regarded as a probability, although its practical significance is still open to question.

As might be expected, direct transmission of the parasite was demonstrated when the swine ate the infected carcasses of wild animals. This, too, must be regarded as a probable means of transmission of the trichinae parasite from rats and wildlife to swine. The practical importance of this mode of transmission to bridge the gap between the reservoir of the trichinae parasite in rats and wildlife to the swine population is still to be evaluated.

Many investigators have revealed that there is a relatively high incidence of trichinae in rats and wildlife. On the domestic scene, in addition to the rats, the infection has been demonstrated in the mouse, the domestic cat and the dog. In wildlife the infection has been demonstrated in the rabbit, beaver, pole cat, palm civet, wolf, coyote, fox, martin, ferret, badgers,

raccoon, polar bear, common bear, mongoose, wild boar, coypu, hedge hog, marmot, mole, hippopotamus, porcupine, skunk, muskrat, seal, white whale, moose, deer, and mink.

*Human Beings.*—Investigators continue to report a high incidence of the trichinae parasite in human beings. These reports are the result of examining tissue specimens taken from the diaphragm of humans in connection with routine autopsies. A complete report of such examinations is given in an article entitled "Studies on Trichinosis" which has been published in the Public Health Reports under date of May 26, 1944, 59, No. 21. This is a report of examinations made of diaphragm material from 5,303 individuals coming to necropsy of which 855 or 16.1 per cent were

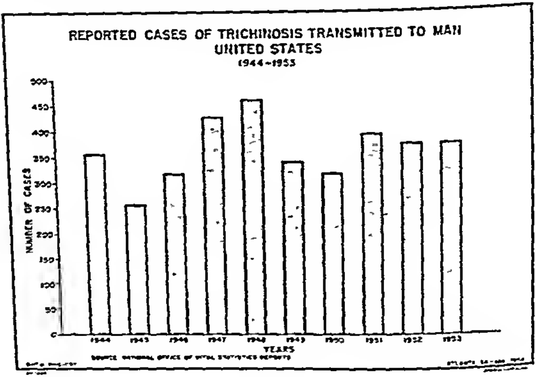


Fig. 51.

found positive for the parasite. More recent investigations support those figures and it can be expected that the subject of trichinae will continue to be one of public interest.

These findings of the trichinae parasite in the diaphragms of humans take on perspective when they are considered along with the clinical manifestations of the disease trichinosis. This is expressed graphically and convincingly in Figure 51 prepared by the Atlanta office of the Communicable Disease Center of the Public Health Service, Department of Health, Education and Welfare, dated January 1954.

**Control.**—Because trichinosis does not lend itself to be detected and handled like other parasitic conditions in connection with meat inspection post-mortem examinations made of swine carcasses, it is necessary to

devise some other method of control which would safeguard the consuming public against this parasite. Considerable study has been given to this problem by agencies such as the U. S. Public Health Service and the United States Department of Agriculture and those State offices in the United States which have meat hygiene responsibilities. Methods of control employed in countries outside the United States are not being considered in this text since they must be considered to have only academic interest as applying to conditions differing sharply from those encountered in the United States. Since the hearings and surveys conducted by the New York State Trichinosis Commission and the Committee on Public Health Relations of the New York Academy of Medicine have gone thoroughly into an evaluation of the various methods of control, the following contains many quotations from the reports made by those groups.

**Garbage Treatment.**—The New York State Trichinosis Commission in its report of 1942 states, in connection with statistics giving the incidence of trichinosis in garbage fed hogs, that "these figures which are based on careful epidemiological studies indicate that in the territory covered, rodents play only a minor role in the transmission of trichinosis to swine and that the feeding of raw garbage is a much more important factor in maintaining the disease."

The following is quoted from the Commission's 1941 Report:

> "Human trichinosis is based almost entirely on porcine trichinosis. And porcine trichinosis is based almost entirely upon feeding hogs raw garbage containing trichinæ infested pork scraps. 'The common occurrence of pork scraps, including those not so cooked or processed as to kill trichinæ, in garbage and swill, and the eating of such scraps by large numbers of swine, are well-established facts,' Dr. Hall[1] pointed out. 'Americans throw into the garbage cans much more food than is thrown away by other nations, and as they rank about fifth in amount of meat per capita purchased, the discarded food includes a great deal of meat. This is especially true of so-called hotel garbage, which is definitely high in discarded meat, although the less valuable alley garbage, the household garbage, contains more meat in the United States than it does in other countries.
>
> 'It is the testimony of the field veterinarians of the Federal Bureau of Animal Industry that pork scraps are usually present in garbage and swill. The veterinary field force engaged in hog-cholera control has paid special attention to this subject for many years in tracing outbreaks of hog cholera; and in the State of Maryland, where this subject was given particular investigation by Dr. I. K. Atherton and his field force, approximately 80 per cent of outbreaks of hog cholera were traced to garbage containing uncooked pork scraps. The extent of garbage feeding varies locally in accordance with the amount and kind of feed available, and over the Middle West, with plenty of grain available, there is relatively less garbage feeding than along our seaboards. It varies also with the price of pigs above 6 cents a pound, garbage feeding is profitable in Maryland, and with prices below 6 cents it is not profitable. The precise critical price would vary with different swine growers and other factors.
>
> 'There are, usually, approximately thirty million to forty million hogs slaughtered annually in the United States, and the scraps of pork from these millions of hogs are trimmed out in butcher shops, hotels, homes, and elsewhere for various reasons—spoilage, discoloration, etc.—and these trimmings and other discards are thrown into the garbage. Between 1 and 5 of every 100 of these discards, on an average, will contain live trichinæ, and the total scraps,

[1] Before his death in 1938, Dr. Maurice C. Hall was Chief, Division of Zoology, National Institute of Health, U. S. Public Health Service.

The treatment of garbage to destroy the trichina parasite when the garbage is to be fed to swine constitutes an important phase in the control of trichinosis in the United States. Laws and regulations requiring such treatment are of no avail in the absence of such regulatory control as is necessary to assure compliance. Following is quoted a United States Quarantine Regulation which by its first provision identifies trichinosis as a "Quarantinable Disease" and requires by its second provision that garbage be thoroughly cooked when it is intended to be used for feeding swine.

"AMENDMENT NO. 5 TO THE UNITED STATES INTERSTATE QUARANTINE REGULATIONS, PUBLIC HEALTH SERVICE

Federal Security Agency
Office of the Administrator
Washington, D. C.
October 11, 1941

In accordance with the provision of the Act of Congress approved February 15, 1893, the United States Interstate Quarantine Regulations are hereby amended to make Section 1 read as follows:

Quarantinable Diseases

1. For the purpose of interstate quarantine the following diseases shall be regarded as contagious and infectious diseases within the meaning of Section 3 of the Act approved February 15, 1893: Plague, cholera, smallpox, typhus fever, yellow fever, typhoid fever, paratyphoid, dysentery, pulmonary tuberculosis, leprosy, scarlet fever, diphtheria, measles, whooping cough, epidemic cerebrospinal meningitis, anterior poliomyelitis, Rocky Mountain spotted or tick fever, syphilis, gonorrhea, chancroid, anthrax, influenza, pneumonia, epidemic encephalitis, septic sore throat, rubella, chickenpox, psittacosis, and trichinosis.

Also as part of this amendment there shall be added to these Regulations Section 14½, as follows:

Use or Shipment of Garbage

14½. No person, firm, or corporation shall offer for shipment in interstate traffic, or shall accept for shipment or transport in interstate traffic any garbage intended to be used for feeding swine unless all particles of such garbage have been heated to a minimum temperature of 212°F., and held at that temperature at least thirty minutes in apparatus and by methods approved by the State or local health officer: Provided, That this requirement may be waived where such heat treatment of garbage intended for swine feeding is carried out at destination under State or local statutes, ordinances, or regulations.

PAUL V. MCNUTT,
*Administrator*"

As an example of a State requirement for the cooking of garbage intended to be fed swine, following is quoted an Act of the New York State Legislature:

"GARBAGE COOKING LAW
CHAPTER 214, LAWS OF 1942

An Act to amend the general municipal law, in relation to disposal and treatment of garbage

The People of the State of New York, represented in Senate and Assemhly, do enact as follows:

Section 1. Chapter twenty-nine of the laws of nineteen hundred nine, entitled "An act in relation to municipal corporations, constituting chapter twenty-four of the consolidated laws, is hereby amended by inserting therein a new section, to be section one hundred and tbirty-five-d, to read as follows:

§ 135-d. Disposal and treatment of garbage. Any contract made or any permit issued by a municipal corporation or any puhlic or private institution therein for the sale, collection or disposal of garbage shall require that the garhage be boiled for not less than one-half hour before it shall be used for the purpose of feeding pigs, hogs or swine.

§ 2. This act shall take effect immediately."

**Garbage and Animal Disease Control.**—Vesicular exanthema is a viral vesicular disease of swine that cannot be distinguished in the field from foot-and-mouth disease. Occurrences of this vesicular swine disease must therefore receive the same kind of attention as would be given occurrences

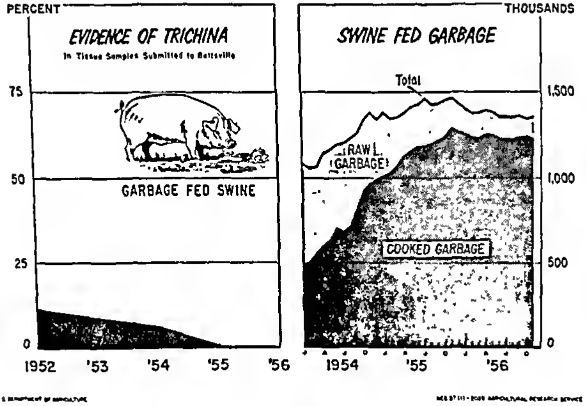


Fig. 52.

of foot-and-mouth disease until laboratory and animal passage tests determine conclusively that the disease is in fact vesicular exanthema and not foot-and-mouth disease. The incidental necessary quarantine and control procedures occasioned by the occurrence of vesicular exanthema in the United States are costly both for the swine producer and the meat packer. As a result the Federal and State Animal Disease Control agencies receive the cooperation of these industries in the eradication of the disease.

For many years vesicular exanthema occurred enzootically in California. The disease did not receive National attention until it spread from California to the Midwest in 1953 and from there it rapidly fanned out into

from almost 100,000 hogs daily, which will contain live trichinæ from approximately an indicated 1,000 to 5,000 infested hogs, will run into many thousands daily. The feeding of swine of such scraps, as constituents of garbage or swill, constitutes a dependable, large-scale, year-round source of trichinæ for swine. At times the feeding of pork scraps in garbage takes the form of a case reported in the New Jersey press in 1933, in which part of the sausage responsible for 28 clinical cases of human trichinosis, with at least 1 death, was thrown into garbage cans and the garbage distributed to many hog pens.'

"Geographical areas in which many hogs are raised on garbage are the areas having the most cases of clinical trichinosis.

"Dr. Willard H. Wright, of the National Institute of Health, reports that there is 'even some further correlation between the percentage of cities feeding garbage to hogs and the trichinosis morbidity rate. For instance, the Pacific Coast States, in which 82.8 per cent of the cities concerned dispose of garbage by feeding it to swine, have the highest morbidity rate of any section. The New England States, with the next highest morbidity rate, lead all other geographical areas in the number of cities using the hog-feeding method of disposal.'

"Swine fed on cooked garbage and Southern swine raised generally in fields and woods without easy access to garbage or kitchen scraps rank in the lowest order of importance as sources of human trichinosis. Only about 0.5 per cent of these swine have been found to harbor trichinæ.

"Next in order of importance are so-called grain-fed swine, as represented largely by swine from the Central West, of which 1.05 to 1.5 per cent have been found infested with trichinæ. If we exclude the rat as a major factor in the causation of swine trichinosis, it is apparent that these so-called grain-fed swine have not been raised exclusively on grain or on pasture crops but that many of them have received some garbage probably in the form of scraps or swill from the farm kitchen.

"Swine fed on uncooked garbage rank next in the order of importance as a source of human trichinosis and probably today (1942) represent the chief source of the disease in man. Since 4.5 to 5.0 per cent of these swine are infested with trichinæ, they are approximately 10 times more important as a source of trichinosis than are Southern swine and swine fed on cooked garbage."

Again quoting from the 1941 Report of the Commission appears the following under the heading "Prevention of Feeding of Raw Garbage."

"The situation today plainly indicates," Dr. Wright states, "that methods of garbage disposal have not kept pace with the marked improvements effected during recent years in other municipal sanitary services. While no effort has been made to obtain such information, it seems safe to assume that nearly all, if not all, of the cities utilizing the hog-feeding method of garbage disposal have sewage and water systems sufficiently adequate for the prevention of fecal-borne diseases. Many of them have food-inspection services and probably most of them have milk ordinances based on the standard ordinance of the United States Public Health Service or ordinances equivalent to that ordinance. Thus, most of these municipalities have probably provided adequate protection against most of the diseases spread through food or water; however, in the case of trichinosis they are not only failing to provide adequate safeguards but are contributing to the spread of infection.

"The persistence of such an outmoded method of garbage disposal is accounted for in part by the revenue which many cities derive from such refuse. Some municipalities receive a sizable amount of income from the sale of garbage. Others, which merely furnish the garbage gratis to hog feeders, while not profiting directly, are relieved of the expense of disposal. With the present burden of taxation, any method of refuse disposal which represents a saving to the municipality appeals alike to the city official and the taxpayer. The general application of any suitable method or methods for the sterilization and processing of garbage so that its value as an animal food might be safely conserved

would help solve the present problem. However, the economic factor is not the factor of prime importance. With such things as the use of night soil as fertilizer, we have long since disregarded the economic factor in favor of benefits to community health.

"State and local health officials may well assume the leadership in remedying the present anomalous situation. Effort should be made to encourage disposal by methods which are accordant with accepted public health standards. Until facilities are available for sanitary methods of disposal, it would be desirable for cities to include in contracts for garbage removal and disposal provisions for adequate cooking of garbage before its consumption by swine. In those cities already employing sanitary methods of disposal but benefiting from garbage sold or furnished gratis to farmers and hog feeders, the public health aspects of the matter should be considered and effort made to curb such practices.... Under present conditions, it would appear that little can be accomplished in the way of controlling trichinosis so long as our cities and towns continue their substantial contributions to the spread of the disease and serve as flagrant examples for others to do likewise."

As an example of the magnitude of planning control measures aimed at the cooking of garbage intended to be fed to swine, the 1941 Report comments on "The Secaucus Situation" as follows:

"Just outside New York, in Secaucus, New Jersey, there are nearly 50 vast hog farms on which garbage collected from New York City and New Jersey is fed raw to hogs. The live or dressed hogs are then shipped into New York City and the metropolitan area, where in the form of pork products they reach the consumer's table.

"What can be done about this situation? The fact that the hog raisers are outside the jurisdiction of New York State complicates the problem.

"The City of New York forbids any person to remove, dispose of, convey, or transport upon the streets or bridges or over the ferries in the City, manure, swill, garbage, etc., without having first obtained a permit from the Commissioner of Sanitation. Deputy Commissioner John B. Morton, of the New York City Sanitation Department, informs this Commission that as of September 26, 1940, there were 101 permits outstanding to vehicles engaged exclusively in the collection of swill (wet garbage, exclusive of ashes and rubbish). Most of these vehicles collect swill from restaurants and hotels, and, we believe, pay the producer of the swill for the privilege of taking it away.

"Of the 101 vehicles engaged in collecting swill, the residence of the operator on 97 of the permits is given as New Jersey: 3, New York City; 1, Rockland County. Deputy Commissioner Morton states: 'It is believed that the 97 vehicles, on the permits of which New Jersey is shown as the residence of the operator, are engaged in transporting the swill collected to New Jersey and that it is used preponderantly for hog feeding. We know definitely that none of these 97 vehicles use our facilities for the disposal of the swill collected. We do not know how the other 4 vehicles dispose of the swill collected, but we do know that they do not use our facilities for its disposal. We believe that these 4 permit vehicles are disposing of the swill collected for hog feeding; we are certain that they are not using our facilities for its disposal, and to dispose of it otherwise in the City of New York is unlawful.'

"The New York City Sanitation Commission estimated that these 101 licensed trucks collect about 1,212 cubic yards of swill per day. If New York City were to undertake to collect and incinerate this garbage, it would cost the city about 30 cents per cubic yard for incineration and about 65 cents per cubic yard for collection, a total of 95 cents per cubic yard. Thus, if New York City were to ban collection of garbage for hog-feeding purposes, the cost of municipal collection and disposal of this garbage would amount to over $1,000 a day."

all sections of the country. Eradication measures were promptly instituted and the economic importance of the disease became recognized by all segments of the agricultural economy. Experiences gained during the eradication program demonstrated the role of importance played by the feeding of swine with uncooked garbage in the dissemination of the disease. Therefore, as part of the program of eradication of the vesicular disease, a campaign was organized to prohibit the feeding of uncooked garbage to swine.

Reports indicate that the campaign aimed at the prohibition of feeding uncooked garbage to swine has met with substantial success. The importance of this development as it has a relation to the control of trichinae was promptly recognized. This relationship is graphically described by Figure 52. The geographical area used in the surveys made before and after the feeding of cooked garbage as reflected by Figure 52 has a background of study in connection with the occurrence of the trichinae parasite. Considering the area studied and the number of specimens examined in connection with the surveys the results appear to justify a finding in support of the long-held opinion that the feeding of uncooked garbage in the United States accounts in large part for the distribution of trichinae infection in this country.

**Microscopic Examination.**—Microscopic examination of samples of pork muscle tissue taken at the time meat inspection post-mortem examination is made of a swine carcass has been a recognized method of trichinosis control in Europe for many years. Early Federal meat inspection procedures in the United States which had their beginning with the Act of Congress approved August 30, 1890, were patterned after European practices, principally those followed in Germany. By regulation of the United States Department of Agriculture, dated March 25, 1891, microscopic examination of samples of pork muscle tissue were required to be made, and by regulation dated June 14, 1895, such examinations were limited to pork intended for export. The following paragraph is quoted from the regulation of June 14, 1895:

> "19. The microscopic inspection of pork intended for export to countries requiring such inspection shall be conducted as follows: When the slaughtered hog is passed into the cooling room of said establishment, the inspector in charge, or his assistants, will take from each carcass three samples of muscle, one from the 'pillar of the diaphragm,' one from the psoas muscle, and the other from the inner aspect of the shoulder, and said samples will be put in a self-locking tin box and a numbered tag will be placed upon the carcass from which said samples have been taken, and a duplicate of said tag will be placed in the box with said samples. The boxes containing the samples from the hogs in the cooling room, so tagged, will be taken to the microscopist for such establishment, who shall thereupon cause a microscopic examination of the contents of each box containing samples to be made, and shall furnish a written report to the inspector, giving the result of said microscopic examination, together with the numbers of all carcasses from which samples have been examined."

These microscopic examinations were discontinued in 1906. Since that time there have been no microscopic examinations made in the United States as a routine meat inspection procedure in connection with post-

mortem examinations made incident to the preparation of pork for human food.

The statement of policy made by the United States Department of Agriculture in connection with the decision of its Federal Meat Inspection Service to discontinue microscopic examinations appears in the Annual Report of the Bureau of Animal Industry for 1906 as follows:

"Pork Not Examined Microscopically for Trichinæ

While the Federal meat inspection in this country is as thorough as a comprehensive law, stringent regulations, and a liberal appropriation of money can make it, and the consumer of meats bearing the stamp "U. S. Inspected and Passed" may in general have the comfortable assurance that he is buying and eating products from healthy animals prepared under clean and sanitary conditions and the danger of contracting disease from eating these meats is practically eliminated, yet the fact should not be overlooked that there is one disease against which the meat inspection legend does not pretend to be a safeguard. For the detection of most of the diseases affecting meat the human eye needs no assistance. The disease called trichinosis, however, to which hogs are subject, is caused by a parasite so small that the microscope must be employed to detect it. Thorough curing or thorough cooking of the meat kills this parasite. It seems, however, that some European peoples have a habit of eating raw or half-raw pork, and consequently they have suffered from this disease. Very elaborate measures have been taken in some countries to do away with or to lessen the danger. In Germany, for instance, there is an army of inspectors who use the microscope to detect these parasites in pork. These countries some years ago forbade the importation of American pork products unless they had been microscopically inspected. To meet this requirement the Bureau instituted several years ago a system of microscopic inspection of pork intended for shipment to such countries. No microscopic inspection of pork intended for home consumption, however, has ever been made or even contemplated. The Department takes the ground that from the nature of the disease an examination of certain parts of a hog carcass can only minimize and not eliminate the danger.

"The parasites, it is true, are usually found, if found at all, in certain parts, as the pillar of the diphragm, the psoas muscle, the inner aspect of the shoulder or the base of the tongue. Not finding them in these parts by the usual methods, it may be assumed to be probable that they do not exist in the remainder of the carcass. This is, however, only a probability, as they may exist, and even to such an extent as to produce disease if the flesh is eaten raw. Many cases are on record where twenty, even thirty, examinations were made before trichinæ were found; and out of 6,329 cases of trichinosis in Germany, between 1881 and 1898, a careful inquiry traced 2,042 cases (over 32 per cent) to meat which had been microscopically examined and passed as free from trichinæ. In view of these facts the Department has regarded it as utterly impracticable to inspect hog carcasses for this disease. It has further taken the view that such inspection which as formerly carried on for exported products would cost about $3,700,000 a year if all hogs killed at inspected houses were so examined would do more harm than good. It would create in the minds of the consumers a feeling of false security, which might lead them to omit the only sure means of escaping danger, namely, to refrain from eating uncooked or uncured pork; and it would thus defeat its very purpose and render the great trouble and expense worse than useless.

"Not only has the Department not inspected for trichinæ the pork consumed at home, but it has abandoned recently such inspection of pork products going abroad. It was found that even after our elaborate examination some foreign countries, although requiring our inspection, paid no attention to our certificates, and conducted an examination of their own, on the result of which de-

pended the admission of the products. On the ground, then, that our examination was superfluous, the Department stopped it. Of the principal countries formerly requiring certificates of this examination Italy and France already have agreed to admit our products without them, and upon the certificate simply of the regular inspection under the present law. It is hoped that other countries will take similar action."

During the public hearings held in 1941 by the New York State Trichinosis Commission considerable attention was given to microscopic examination for trichinæ as a control measure. The following is quoted from the Commission's 1941 Report:

CONTROL THROUGH MICROSCOPIC INSPECTION

Chairman Thomas C. Desmond, at a public hearing held by this Commission, said:

"When Germany and France banned the importation of American pork toward the close of the 1800's, our federal government required that pork designed for export be subjected to microscopic inspection. A little more than one out of fifty hogs were found to be infected. With the passage of the federal meat inspection act in 1906, microscopic inspection was abandoned, and in its place there was substituted the present regulation requiring the processing of pork products customarily eaten without cooking. Microscopic inspection is in force in Germany today. But most authorities seem to agree that this method is impractical, too costly, and would give our people a false sense of security."

Dr. Maurice C. Hall, in 1938, wrote:

"The meat-inspection statistics of Germany give convincing evidence that microscopic inspection of pork leads in the direction of eradication of both human and porcine trichinosis in Germany, since the incidence of both have fallen to exceedingly low figures during the past half century. That inspection has fitted into the more leisurely slaughter-house procedures of Germany, and although it now costs many thousands of dollars to find one trichinous pig, that alone is evidence that it is accomplishing its mission in the control of trichinosis. Under the high-speed procedure of American packing plants, microscopic inspection for trichinæ would require the training and use of a regiment of inspectors at a cost exceeding our present total cost for meat inspection. It would be especially expensive and difficult if anything approximating the present speed of plants were maintained, and in all probability it would slow down those procedures. If unaccompanied by changes in our methods of swine production, it would mean enormous expenditures for perhaps fifty or one-hundred years. Unless it were nationwide, which would call for legislation by all of the States, it would unquestionably be dangerous, since its application by the federal government to interstate shipments alone would give a false sense of security in the consumption of a pork supply that was a mixture of inspected and uninspected pork as marketed and served. So long as there is a simple and inexpensive control measure in sight, this alternative may be regarded as one of those last painful measures which should be taken only under stress of necessity."

Speaking at the public hearing conducted by this Commission, Dr. Benjamin Schwartz discussed meat inspection aspects of trichinosis. A portion of his discussion concerned microscopic inspection of pork products. He said:

"Following the discoveries made in Germany in 1860 regarding the mode of transmission of trichinæ through the consumption of raw pork and the demonstration, at about the same time, that these parasites are injurious to human health, the medical profession and, in fact, the general population of that country became trichina conscious and alarmed over the possibility of acquiring from pork a serious and sometimes a fatal disease. Since the people

of northern Germany commonly ate raw pork it became quite evident to the sanitary authorities of that country that serious consequences were apt to follow the indulgence in this habit.

"On the heels of the discoveries concerning trichinosis, serious outbreaks of this disease in small towns in Germany actually came to light. As a result of these and other outbreaks of trichinosis the German government instituted a system of microscopic inspection of pork which, so far as is known has survived until the present time, and has been imitated by other, but not all, countries on the European continent. The establishment of microscopic inspection in any country is a frank recognition by public health authorities that they have to reckon with a custom, deeply rooted in the general population, that regulates the cooking of pork by the palate rather than by the thermometer.

"That the United States at one time had a microscopic inspection of pork for trichinæ appears to be well known, owing to the numerous articles on trichinosis that have appeared in newspapers and magazines in recent years. What is not so well known, perhaps, is the fact that the microscopic inspection of pork for trichinæ that was practiced in this country under Federal meat inspection for a period of fifteen years (1891 to 1906) did not apply to all hogs slaughtered in officially inspected establishments. Actually, it applied only to pork intended for export to certain countries in Europe which required this inspection. The admittance of pork from the United States to certain European countries was prohibited unless the shipments were accompanied by certificates setting forth the facts that the pork had been inspected microscopically and found free from trichinæ. In short, the motives that led to microscopic inspection of samples of pork from each hog designed for the export trade were economic rather than hygienic. This inspection did not apply at any time to the total hog slaughter that was subject to Federal inspection.

"Although trichina inspection with the microscope, as practiced in this country, was done in the accepted manner by microscopists who were under constant professional supervision, experience with this inspection was such as to warrant the belief that even when carried out conscientiously, such inspection does not and cannot offer an absolute guarantee that any carcass passed as free from trichinæ, is really uninfected. According to statement published by German meat inspection experts, samples of pork from this country certified as being free from trichinæ were found, in some cases, to be infected after being reinspected at their destination. This is not surprising, considering the fact that only about 3 small samples, each about the size of an oat grain, were examined, in accordance with the usual custom, following their compression between glass slides. Since trichinæ are not uniformly distributed throughout the muscles, it is quite possible to miss these parasites in particular samples that happen to be taken for examination. It must be admitted that this possibility diminishes in proportion to the intensity of the infection, the parasites in lightly or moderately infected carcasses being more apt to escape detection than those in carcasses that are heavily infected. That the American system of microscopic inspection of pork was not inferior to that practiced elsewhere was shown as follows: An investigation conducted by the Bureau of Animal Industry of the U. S. Department of Agriculture in Germany showed that out of a total of over 6,000 cases of human trichinosis that occurred in that country in the latter part of the nineteenth century about 33 per cent were caused by pork that had been examined microscopically by German inspectors and certified by them as being free from trichinæ.

"Aside from the inherent imperfection of microscopic inspection as a prophylaxis against trichinosis, other objections, equally serious, have been marshalled against this scheme of prevention. It is reasonable to assume that knowledge of the existence of microscopic inspection would tend to encourage the consumption of raw pork and thereby undo much of the good that the inspection might accomplish by eliminating from the channels of trade carcasses showing marked infection. This knowledge would tend to create in the minds of persons who are fond of raw pork a false sense of security and thereby defeat in a measure the very purpose for which the inspection was intended.

"Another, and perhaps, more serious objection to microscopic inspection in this country arises from the following circumstances. Federal inspection of food animals in the United States is limited to plants that engage io interstate and/or foreign commerce. Plants not engaging in such enterprises do not come under the provisions of the meat inspection act of Congress and are subject only to state or municipal inspection, or are entirely without inspection. Moreover, slaughter done on the farm is exempt from federal and all other inspection. Since few states and not a great many municipalities have a rigid system of meat inspection, it cannot be supposed that all swine carcasses slaughtered in this country would be subjected to microscopic inspection even though such inspection were maintained by the federal government. Very few consumers would take the trouhle to differentiate between pork inspected microscopically under Government or equally competent supervision and pork not so inspected. The confusion that would result from this state of affairs would nullify, at least in part, much of the good that would result from microscopic inspection.

"Aside from the objections already cited, there still remains to be considered the rather serious question of the cost of microscopic inspection. Approximately 40,000,000 hogs are slaughtered under federal inspection anoually, this representing about 60 per cent of the total hog slaughter io the country as a whole. It is safe to state that the cost of microscopic inspectioo would average about 25 cents per hog, so that the annual cost of inspecting for trichinæ under Government supervision would amount to about $10,000,000. Considering the fact that this sum is almost twice that of the present total cost of all federal meat inspectioo, the drain on the public treasury for an iospectioo which, at best, is only partially effective, would hardly appear to be warranted."

**Ionizing Radiatioo.**—The effects of ionizing radiation on the trichinæ parasite have heen studied. These studies have been conducted in connection with the extensive exploratory work to find commercial outlets for radioactive fission products. Gamma radiation appears to be the most practical, considering that the sources of such radiation are spent fuel assemblies, fission product materials, reactor-produced isotopes, and reactors.

It has heen found that a radiation dose of ahout 1 million roentgens is necessary to kill the trichina larvae. However, a much lower radiation dose of about 10,000 roentgens was found to be adequate to sterilize sexually the female larvae. Such action would, of course, break the trichina cycle.

Somewhat extensive and expensive installations would he required to handle the gamma ray emitter. The adaptation of such a device to a large and widespread industry has presented prohlems which so far have stood in the way of the practical application of ionizing radiation to the trichina complex.

**Treatment of Pork Products Customarily Eateo Without Cooking.**—The Federal Meat Inspection Service faced witb the problem of working out a program of trichina control within the area of its responsibility requires that all pork products which are customarily eaten without cooking that are prepared under its supervision be treated by one of the methods prescribed by its regulation to destroy any live trichina whicb may be present in the product. The Federal meat inspection regulations which outline in detail these requirements appear on page 532 of the Appeodix. Under the heading "Processing of Pork" the New York State Trichinosis Commission

in its 1941 report considers fully the position of the United States Department of Agriculture with respect to its requirement for destruction of live trichina in pork products customarily eaten without cooking.

"A regulation of the United States Department of Agriculture states: 'Inasmuch as it cannot certainly be determined by any present known method of inspection, whether the muscle tissues of pork contain trichinæ, and inasmuch as live trichinæ are dangerous to health, no article of a kind prepared customarily to be eaten without cooking shall contain any muscle tissue of pork unless the pork has been subjected to a temperature sufficient to destroy all live trichinæ, or other treatment prescribed by the chief of the bureau.'

"It should be emphasized that this requirement does not affect meat products made and sold within a single state, and that this requirement does not affect pork products customarily cooked by the consumer. It should also be stressed that the legend 'U. S. Inspected and Passed' on fresh pork or on ordinary varieties of cured pork which the consumer customarily cooks does not mean that the product so marked is free from *Trichinella spiralis;* it merely means that the meat has been inspected in the same way that all meat is inspected in establishments operating under federal inspection.

"Dr. Benjamin Schwartz, speaking at the November 28, 1940, public hearing held by this Commission said: 'In the absence of any known practical inspection to determine whether the muscle tissue of pork contains trichinæ, no guarantee of any kind as regards the freedom from these parasites can be given in the case of fresh pork in all forms. This includes not only the various cuts of fresh pork, but also fresh sausage containing pork muscle tissue, and such cured or smoked pork as ordinary hams, shoulders, shoulder picnics, bacon, and jowls, all of which are considered as articles which are or should be well cooked in the home and elsewhere. Under federal meat inspection, all products containing pork muscle tissue to be sold as cooked products or as cured products that are fit for consumption without cooking, are treated by methods which are known to be destructive to the vitality of trichinæ. In this category are included bologna-style sausage; frankfurt-style sausage; Vienna-style sausage; smoked pork sausage; chopped, cured meat rolls; all forms of summer and dry sausage; cured, boneless pork loin; fresh, boneless loin in casings; boneless, back bacon; roast, baked, cooked or boiled ham, shoulder or shoulder picnic; Italian-style ham; and other products commonly intended for consumption without cooking.

"Dr. Schwartz also said in a recent report:

'The treatments prescribed by the Chief of the Federal Bureau of Animal Industry for all meat food products containing pork muscle tissue that are prepared to be eaten customarily without cooking, are (1) heating, (2) special refrigeration, and (3) special processing, these procedures having been found by extensive, painstaking scientific investigations to be deleterious to the life of trichinæ. Under the prescribed heating it is required that all meat food products of kinds mentioned must be so heated that they will attain in all parts a temperature of not less than 137° F. The required refrigeration involves the subjection of pork or of articles containing pork muscle tissue to a temperature of not higher than 5° F. for a continuous period of not less than twenty days, provided the meat or articles, not exceeding 6 inches in diameter, are hung singly up or packed in boxes not exceeding 6 inches in thickness. In the case of pork or products packed in barrels or tierces, the period of refrigeration is extended to thirty days.

'Owing to more or less recent improvements in refrigeration, it has been determined that meat packing establishments operating under federal inspection commonly maintain their freezers used for treating pork to destroy the vitality of trichinæ at temperatures much lower than 5° F. With this in mind, investigations were conducted recently by the Bureau of Animal Industry to determine the extent to which the required holding period of pork and products could be decreased if the temperature of the freezer is maintained

at 10° F. The results of these investigations showed that when pork is packed in boxes not exceeding 6 inches in thickness the required holding period in freezers maintained at −10° F. could be reduced to ten days and that when the meat or products are packed in tierces, the period of refrigeration need not be extended beyond twenty days. Tests were made also with trichinous pork kept in freezers maintained at a temperature of −20° F. As would naturally be expected, it was determined that the required holding period at this low temperature for pork packed in boxes not exceeding 6 inches in thickness could be still further reduced, actually to six days, and for pork packed in tierces the period could be reduced to twelve days. These results show, therefore, continued progress in investigations of and ultimate application of practical methods designed to destroy the vitality of trichinæ in pork destined to be converted into products of kinds customarily eaten by the consumer without cooking.'

"Dr. J. R. Mohler, Chief of the United States Bureau of Animal Industry, informed this Commission as follows:

'The recent regulations concerning the refrigeration of pork at −10° F. and −20° F. are based on 205 distinct tests, each test having been conducted in a large meat packing establishment in Chicago. The tests were conducted as follows: Trichina-infected pork, together with other pork furnished by a large meat packing company, was packed in tierces, 27 inches in diameter, and in boxes not exceeding 6 inches in diameter. The boxes and tierces were held at temperatures of −10° F. and −20° F., respectively, for specified periods. At the end of the holding period, the trichinous meat, which was in the center of the box or tierce, wrapped in muslin, was removed, allowed to thaw, and a small portion of it was digested in artificial digestive fluid in an incubator; the remaining meat, or such portions of it as necessary, was fed to a series of several rats, these animals being kept for at least thirty days before being slaughtered. The sediment of the digestive fluid was carefully examined for trichinæ and various tests were made to determine whether the trichinæ recovered were dead or alive. The diaphragm of each rat was examined for trichinæ and if no worms were found the entire carcass, which was skinned and eviscerated, was digested in artificial gastric juice and the sediment was examined for trichinæ.

'In experiments involving refrigeration of trichinous pork in tierces at a temperature of −10° F., 25 distinct tests were conducted and in no instance were trichinæ found in the muscles of rats to which this frozen meat had been fed; in experiments in which the trichinous meat was packed in boxes, 79 tests were conducted with consistently negative results.

'In experiments involving a temperature of −20° F., 25 tests were conducted with trichinous pork packed in tierces and 76 tests were conducted with trichinous pork packed in boxes. The results of this series were negative throughout.'"

**Refrigeration of Pork.**—With the knowledge that low temperatures will destroy the live larvæ of trichinæ in pork muscle tissue, consideration has been given from time to time to the probability of having all pork produced in the United States treated by freezing to make it safe against trichina. Interested parties have been encouraged to believe that such a method of control might be practicable in view of the availability of refrigeration in connection with meat packing and meat distribution facilities.

The Committee on Public Health Relations of the New York Academy of Medicine held hearings and examined into the question generally of control of trichinosis with emphasis particularly on the probability of treating the entire pork supply of the United States with low temperatures to destroy trichinæ. The Committee's report is published in the April 9, 1948, issue of the Public Health Reports of the United States Public

Health Service. This report contains interesting summations concerning the incidence of trichinosis and methods for its control. The following is quoted from that part which evaluates the use of low temperatures for the treatment of all pork produced in the United States.

"PORK PROCESSING, WITH SPECIAL REFERENCE TO FREEZING

Gould[1] advocated Federal, State, and local regulations requiring that all pork be processed. He expressed the opinion that if all pork were processed, trichinosis would be quickly eliminated from hogs, since they acquire the infection principally from eating pork scraps in garbage.

A less sweeping proposal would extend the requirements for processing to cover products which usually are cooked, but are sometimes eaten raw or inadequately cooked. A representative of the New York City Department of Health stated that in 888 of 1,075 cases of trichinosis reported in New York City from 1934 to 1944, the histories indicated that the patients had eaten products of this kind. For these products no processing is now required by the regulations of the United States Department of Agriculture. The Department, however, requires processing of all other types of pork products; these must be heated to a temperature not lower than 137° F., cured by salting and smoking, or frozen. In the slow freezing process now recommended by the Federal regulations, pork products less than 6 inches thick are held at 5° F. for twenty days. Products in pieces more than 6 and less than 27 inches thick must be held for thirty days. Shorter periods are permitted if lower temperatures are applied; that is, ten days for small pieces and twenty days for those more than 6 inches thick at −10° F., and six to twelve days, respectively, for the two sizes at −20° F.

In New York City there are regulations requiring that unless a processor uses pork previously frozen, he must heat thoroughly before selling any pork product customarily eaten uncooked. In a report of 84 cases of trichinosis in the city in 1945, Shookhoff and his associates[2] recorded that the pork used in the meats that caused the outbreak had not been frozen as recommended; it was said that refrigerating companies licensed to do this work had found it more profitable to use their facilities for other purposes, and consequently the practice of freezing pork had been discontinued.

Modern quick-freezing methods have not been adapted for use in the processing of pork. Augustine[3] experimented in 1933 with raw pork loin roasts in which infected guinea-pig muscle had been inserted. Then the infected cuts were brought rapidly to low temperatures varying from −18.1° to −34.6° C. (Note: −17.8° C. is equivalent to 0° F.). It was found that the parasites were not injured until the temperature reached −27.6° C. Complete destruction was attained, however, when trichinous material was lowered to −18° C. and held at that point for twenty-four hours. Dr. Augustine presented these figures before the subcommittee.

A report of a similar investigation was published in 1934 by Blair and Lang.[4] These investigators used rat muscle in order to determine whether a different species of test animal would produce different results. Resistances to freezing were greater than those observed by Augustine. Blair and Lang found that larvæ encysted in rat muscle could be killed by rapidly lowering the temperature to −35° C., but not until the muscle had been held at the lower temperature for two hours. They were of the opinion that it would be impracticable to use this method commercially because of the slow rate at which large volumes of pork and pork products cool. After experiments with pork roasts, the investigators concluded that commercial quantities of pork rapidly

[1] Gould, S. E.: Bull. N. Y. Acad. Med., *21*, 616, 1945; J. A. M. A., *129*, 1251, 1945.
[2] Shookhoff, H. B., Birnkrant, W. B., and Greenberg, M.: Am. J. Pub. Health, *36* 1403, 1946.
[3] Augustine, D. L.: Am. J. Hyg., *17*, 697, 1933.
[4] Blair, J. B., and Lang, O. W.: J. Infect. Dis., *55*, 95, 1934.

frozen to −17.8° C. must be stored at the same temperature for more than forty-eight hours. When ground meat was frozen rapidly, encysted trichinal larvæ were killed in a few minutes. They concluded that additional investigation on the efficacy of quick freezing of heavily infected pork was imperative. They also suggested that studies of the effect of the age of the larvæ and of the relation between resistances to cold of different species of animals would add value to comparisons of methods.

The committee consulted the American Society of Refrigerating Engineers for information concerning developments in freezing techniques and the costs involved. That society's Technical Committee A-3 on Meat Packing, in a report prepared especially for the Committee on Public Health Relations, expressed the opinion that the freezing of all pork to destroy trichinæ is impracticable under present conditions and that if freezing were practicable it would materially increase the cost of pork to the consumer. Members of the engineers' committee are as follows: J. P. McShane, Swift and Co,. Chicago, chairman; H. K. Gillman, Tobin Packing Co., Fort Dodge, Iowa; T. A. D. Jones, Kingan & Co., Indianapolis; F. P. Neff, Tupman and Thurlow, Chicago; Starr Parker, H. H. Meyer Packing Co., Cincinnati; R. W. Ransom, John Morrell and Co., Ottumwa, Iowa; H. H. Shulman, Hammond Standish & Co., Detroit; K. E. Wolcott, Wilson & Co., Chicago, and J. S. Bartley, Rath Packing Co., Waterloo, Iowa.

The engineers estimated that it would require the equivalent of all the present freezer capacity in the United States to process all the pork produced, if the slow freezing now recommended by the Department of Agriculture were employed. If quick freezing methods should be developed, less space would be required, but more insulation and more refrigerating compressor displacement capacity would be necessary and the operating costs would then be higher. Moreover, other new facilities would be required in packing plants. Among such facilities were mentioned: Refrigerated space for wrapping and packaging the pork before freezing; storage space for boxes, cartons and other supplies, and new 'thaw rooms' with controlled temperature, humidity and circulation of air for defrosting the pork to be cured. The engineers claim that to provide additional space it would be necessary to make extensive changes in plants or to utilize new public cold storage space.

Increased costs, which would be borne by the consumer, would arise partly from the acquisition of the new equipment and the extra space needed for large-scale refrigeration, and partly from the extra handling entailed in the freezing process. No actual estimates of the cost were submitted.

Certain other objections to freezing were advanced by the engineers: (1) The investment in the product and in special supplies would add to the risk of doing business; (2) the 'dripping' and color of frozen pork make it unattractive; (3) the necessity for keeping the product frozen until it was ready for cooking would further complicate the handling and would necessitate special equipment in retail stores; and (4) it would be impossible to supervise the freezing of pork from hogs slaughtered on farms. The opinion was also expressed that regulations requiring the freezing of all pork might engender false feelings of security, since a small proportion from establishments which were not under effective inspection might still harbor trichinæ. Some of the difficulties cited are probably exaggerated. Many retailers now have installed freezers in their stores for other frozen products; the danger from lack of supervision of individual farms would not be increased by a requirement for freezing. The matter of chief importance is the question of increased cost for a food which is as wholesome and popular as pork is.

A proposal to refrigerate all pork was advanced several years ago, but packers at that time declined to consider the idea on the ground that their facilities were inadequate. In the opinion of one observer, cooperation on the part of the packers with Federal, State, or local authorities on the control of trichinosis has never been forthcoming; it was his impression that the main attention of the trade had been directed to lessening publicity concerning the disease,

because it was feared that publication of facts relating to it would react adversely on the industry.

In the recent statement on refrigeration, Gould commented that 'the main costs connected with this method of control of trichinosis are the costs of apparatus, such as refrigerating units and storage space. These expenses are initial ones and similar initial expenses would be found necessary in any other method. The operation or maintenance of the method, however, would require relatively little personnel as compared with microscopic inspection, and the method of processing would, therefore, be much cheaper. In the last analysis the cost of this method would be borne by the consumer. The consumer would in fact be glad to assume this extra cost if he could have the assurance that he was receiving meat that was free from living trichinæ.'

In the opinion of Ober,[1] the growing popularity of deep-freeze cabinets in individual homes may be an important factor in encouraging the adoption of refrigeration as a method of destroying trichinæ in pork. If the method was adopted generally, a decrease in trichinosis could be anticipated."

**Diagnosing Trichinosis in Swine.**—Another method of control that has been considered is one which would identify at the time of slaughter those swine which are infected with trichina. The impracticability of testing large numbers of swine as they are brought into packing houses has been fully appreciated. Nevertheless, diagnostic agents and their use have been studied to determine their reliability.

Investigations conducted in 1939 by L. A. Spindler and S. X. Cross of the United States Bureau of Animal Industry examined into the efficacy of intracutaneous tests for the detection of trichina infections both experimentally and naturally acquired by swine. The following is quoted from the discussion contained in the report of these investigations:

"Findings herein reported indicate that the intracutaneous tests used for the detection of trichina infections in swine as applied under conditions of these investigations failed to show that the test can be relied upon to detect all trichina infected swine. Complete failure of various antigens to produce reactions in 29.8 per cent (average) of tests involving infected animals is of utmost importance from a practical standpoint. It was observed that a number of these non-reacting animals were heavily infected with trichinæ. . . . as stated previously, results of tests herein reported indicate that the intracutaneous test as applied for the detection of trichina infections in swine is lacking in specificity and cannot be relied upon to detect all infected animals. If an intracutaneous test for the detection of trichina infections in swine is to be used on a practical basis, it should detect all infected animals irrespective of the age and color or the age and degree of infection. Furthermore, reactions must be of such strength, distinctness, and clarity that they will under no circumstances be masked by wrinkles or pigmented areas in the skin, or be confused with bruises, abrasions, or with any of the other abnormal conditions frequently found on the skin of swine coming to slaughter in abattoirs. In addition, the reactions must be so distinct and clear-cut that they can be readily observed by trained inspectors."

Again in 1940 Spindler and Cross joined by J. L. Avery, also of the United States Bureau of Animal Industry, conducted further investigations concerning intracutaneous tests for the detection of trichina infections in swine. The following is quoted from their report:

[1] Ober, R. E.: New England J. Med., 235, 839, 1942.

"The results of test herein reported are in agreement with those previously published (Spindler and Cross in 1939). Although antigens made by a variety of ways, including chemical fractions of trichina larvæ were tested, none gave reliable results when applied to swine in slaughterhouses. In 11,711 tests on swine at abattoirs, the status of animals as regards trichina infection was correctly detected in approximately 63 per cent of the tests."

**Education.**—Since trichinosis is contracted by man almost entirely by the ingestion of viable trichina larvæ in pork, the destruction of these larvæ before the pork is consumed constitutes a complete safeguard. The method of destruction most readily available to the consumer is cooking. Cooking that raises the temperature of the pork product to at least 137° F. throughout is sufficient to make the product safe against trichina.

The control method employed by the United States Department of Agriculture in its supervision over federally inspected meat packing plants contemplates classifying all pork and pork products prepared in those plants into two categories. One category includes those pork products which are classed as customarily eaten without cooking, such as frankfurter, bologna, and many others which are listed in the regulations on page 532 of the Appendix. The Federal Meat Inspection Service requires that these products be treated by one of the prescribed methods (page 532 of the Appendix) to destroy possible live trichina. The other class of pork products is constituted of those customarily cooked by the consumer before eating and includes such products as pork chops and raw pork generally, bacon, and the like. The inspection has taken no precaution to eliminate or destroy any viable trichina larvæ that may be present in the muscle tissue of these raw pork products. Thorough cooking of such pork products by the consumer before they are eaten protects the consumer against infection.

Education and publicity which emphasize the necessity for cooking pork and its products thoroughly are an important adjunct to trichinosis control in the United States.

The importance of education is recognized in the 1941 Report of the New York State Trichinosis Commission from which the following is quoted:

"CONTROL THROUGH EDUCATION

Dr. Willard H. Wright has stated: 'We might inaugurate an intensive campaign of publicity and thus sound a general alarm, warning the public that one in every six persons is probably infested with trichinæ, that trichinosis is rife, that pork is dangerous and that illness lurks in this important item in the diet of most of our people. Considering that various agencies have for years been utilizing nearly every available means to warn the public to cook pork well, and that these warnings have been followed by no decline in the incidence of the parasite, it does not appear that a continuation or extension of such measures will be of any more value than formerly. It seems that the use of widespread publicity would not only be a futile gesture toward the control of trichinosis but might work incalculable harm to the swine grower and the meat-packing industry. It is evident that a certain portion of the American public prefers its pork rare, just as it prefers its beef rare, and it will probably continue to indulge in its tastes regardless of warnings to the contrary.'

"The immediate aim of education in the field of trichinosis is to impress the consumer with the need of eating pork thoroughly cooked. But, as Senator

Desmond pointed out at the public hearing of this Commission: 'We can no longer make the attack on this pork disease a matter of individual option and private responsibility alone.'

"For years, government officials have been urging housewives and others to cook pork thoroughly. Regardless of what control measures are adopted, it seems clear that this educational campaign must be continued and expanded. An extensive publicity campaign will undoubtedly be helpful in preventing trichinosis, but it is far from being the final solution to the problem.

"This Commission has engaged in considerable educational work, stressing not only the fact that pork should be well cooked, but also that well-cooked pork is a healthful, nourishing food. Daily and weekly newspapers, the press associations, and magazines have cooperated in informing the public as to how trichinosis may be prevented.

"It has been suggested that a coordinated, intensive education drive by our State Health Department, Department of Agriculture and Markets, and Education Department might well be launched. Every medium of education might be used. The United States Department of Agriculture has printed some pamphlets and posters urging thorough cooking of pork. The American Meat Institute has done some work in this field. But it is obvious that much more remains to be accomplished. The goal of a trichinosis educational campaign should be to impress each consumer with the need for eating only pork which is thoroughly cooked."

For many years the United States Department of Agriculture has disseminated information concerning trichinosis, and as part of its meat inspection program it has distributed a great deal of printed material emphasizing the importance of cooking pork products thoroughly before eating. One of the Department's folders is reprinted on page 496 of the Appendix.

**Courts.**—The rights of the individual consumer with respect to his purchase of trichina infected pork and the liabilities of the seller of such pork are best understood by consulting cases on the subject decided by courts in the United States. The attitude of the courts not only has significance with respect to a particular transaction involving rights and liabilities of the parties to a sale of trichinous pork, but it is inevitable that the position taken by the courts will influence the attitude of the American meat packer toward trichinosis controls.

The following cases are listed chronologically. They are of necessity selected cases and represent what appears to be a trend in the decisions by courts from a strict ruling of absolute liability on the part of the seller to a more liberal attitude in his favor. These cases should not be considered as representing the law of the land. An understanding of the rights of any invididual in connection with a case involving trichinosis can be had only by a careful study of the legislation and the decided cases in the particular jurisdiction as they relate to the facts of the particular case.

### Rinaldi v. Mohican Co.

Decided by the Court of Appeals of New York December 10, 1918

Mrs. Rinaldi contracted trichinosis from eating of a pork loin purchased by her from the Mohican Company stores. The lower court decided the case in favor of Mrs. Rinaldi and the Mohican Company stores appealed to the higher court for a review.

In upholding the decision of the lower court in favor of Mrs. Rinaldi, the court of appeals pointed out that the case was not tried on any theory of negligence or fraud but upon that of implied warranty. In deciding the case in favor of Mrs. Rinaldi, the Court of Appeals held that "the mere purchase by a consumer from a retail dealer in foods of an article ordinarily used for human consumption does, by implication, make known to the vendor the purpose for which the article is required. . . . we think further that such a purchase where the buyer may assume that the seller has the opportunity to examine the article sold, unexplained, is also conclusive evidence of reliance on the seller's skill or judgment. . . . Therefore, in case of a purchase of a portion of unwholesome meat from a market after section 96 (Personal Property Law) went into effect, where all that appears is the ordinary transaction between dealer and customer, a charge to the jury that on every sale of food by a dealer for immediate human consumption there is an implied warranty of its wholesomeness, while inaccurate, is harmless. . . . There is no question but what such an action for damages caused by the breach of the implied warranty, with regard to food may be maintained, at least by him to whom the warranty is made. Whether in favor of others we do not determine."

### Cheli v. Cudahy Bros. Company

### Decided by the Supreme Court of Michigan June 4, 1934

Cheli's wife contracted trichinosis as a result of eating uncooked sausage which she prepared from fresh pork butts purchased by her from a retail meat dealer who in turn obtained them from Cudahy Bros. The lower court decided in favor of Cheli, and Cudahy Bros. petitioned the Supreme Court of Michigan for review.

In reversing the lower court and deciding the case in favor of the defendant Cudahy Bros. Company, the Supreme Court considered both counts contained in the declaration, namely, negligence and breach of implied warranty on the part of Cudahy Bros.

In considering the contention of Cheli that the violation of the State Statute which prohibits the sale of adulterated foods is negligence *per se*, the court ruled as follows: "To give the statute such force in this case would in effect impose upon the manufacturer the liability of an insurer regardless of the usual nature of the use to which its product is put . . . . we cannot hold that the legislature intended to impose upon the producer the absolute civil responsibility of an insurer in cases where every reasonable means designed to guarantee the safety of food for normal use has been employed. . . . It seems well established by evidence that the danger to the public is reduced to a minimum if the meat (pork) is thoroughly cooked. The ultimate consumer, however, demands that fresh pork be offered for sale."

With reference to the allegation of Cheli that Cudahy Bros. Company is guilty of a breach of warranty the court ruled as follows: "Nor is there any showing that an implied warranty or condition as to the quality or fitness of raw pork as food in an uncooked condition is annexed to the sale by the usage of trade. . . . It seems to show logically that it is unfair to impose the liability of an insurer upon the meat packer through the implication of a warranty that pork is fit for human consumption in a raw state. This is especially true in view of the fact that the danger of infection can be reduced almost to the vanishing point by ordinary cooking methods. Fresh pork is not ordinarily intended to be eaten raw. The warranty should be applied only to food used in the usual rather than in the unusual and improper manner."

### Zorger v. Hillman's

### Decided by the Appellate Court of Illinois, First Division, First District November 30, 1936

Zorger claims to have bought a pork loin at Hillman's store. The loin was cut into chops which were fried and eaten by Zorger. Zorger claimed to have

contracted trichinosis from eating the pork chops. The lower court decided in favor of Hillman's, and Zorger appealed to the higher court for a review of the case.

In upholding the lower court's decision in favor of Hillman's, the following statement was made as it has a bearing on the implied warranty of fitness for food attaching to a sale of pork: "Plaintiff (Zorger) says that the Criminal Code, Chapter 38, Section 7 . . . forbids selling any flesh of any diseased animal and that this has been construed (in the courts of Illinois) as forbidding the sale of pork containing trichina regardless of the fact that ordinary cooking will make it harmless. The cited case does not so hold but in apt language cites 'that the article sold is sound and fit for the use for which it is purchased.' The use for which pork is purchased is to eat it cooked, not raw. A number of cases in other jurisdictions involved the scientific facts relating to trichinæ and these decisions support our view that pork chops are not sold to be eaten raw and that the wholesomeness required by our Pure Food Statute means that pork is fit for food when properly cooked."

FEINSTEIN *et al.* v. DANIEL REEVES, INC., *et al.*

DECIDED BY THE DISTRICT COURT, S. D. NEW YORK, MARCH 2, 1936

Feinstein claimed to have contracted trichinosis from eating pork chops bought by him from the Daniel Reeves store. In deciding the case in favor of the defendant, Daniel Reeves, Inc., the court pointed out that the cause of action was based upon a breach of an implied warranty by the defendant, Daniel Reeves, Inc., that the pork chops sold were wholesome and fit for human food. The evidence clearly shows that trichina infected pork is wholesome and fit for food when properly cooked. Pork chops are not sold to be eaten in the raw state. The warranty of wholesomeness is not that the pork is free from trichina but rather that it is fit for food when properly cooked.

VACCARINO v. COZZUBO

DECIDED BY THE COURT OF APPEALS OF MARYLAND APRIL 8, 1943

Cozzubo's wife purchased some sausage at Vaccarino's store. Mrs. Cozzubo cooked the sausage for supper and some of it was consumed by each member of the family, all of whom became ill. Their illness was diagnosed as trichinosis. The lower courts decided in favor of Cozzubo, and Vaccarino appealed to the higher court for a review of this decision. In reversing the decision of the lower court, the higher court held that the jury should have been authorized to give a verdict for Cozzubo only in case they found that the plaintiff was infected with trichinosis by eating the sausage after it was cooked in the usual or proper manner.

Since this issue was not presented to the jury at the time of the trial, a new trial was awarded.

The following statements of the court in considering this case are quoted as being declaratory of the law of the particular jurisdiction with respect to implied warranty as it attaches in connection with a sale of pork: "While the rule of *caveat emptor* (let the buyer beware) has generally been applied to the sale of merchandise, the courts have considered the prevention of the sale of unwholesome food by retail dealers to be of such vital importance to the public health that they have recognized an exception in such cases, holding such a dealer liable on an implied warranty of wholesomeness even though he did not know it was unwholesome at the time he sold it. . . . In the case of the sale of food by a retail dealer for immediate consumption the Sales Act is declaratory of the common law holding that there is an implied warranty that the food is reasonably fit for the purpose. . . . However, no implied warranty arises either at common law or under the statute that meat generally fit to be eaten only when properly cooked is wholesome when eaten raw or cooked in an unusual

or improper manner. It is a matter of common knowledge that pork is purchased to be eaten when cooked not when raw. Hence, it would be unfair to impose upon a retail meat dealer an implied warranty that his pork is fit to be eaten when raw. This is especially true in view of the fact that the danger of contracting trichinosis from eating pork can be eliminated by means of proper cooking."

### Sanguedolce v. A. Habermann Provision Co.

### Decided by the Supreme Court of Ohio, July 26, 1944

Benjamine Sanguedolce claimed that he purchased several pounds of raw pork shoulders from the defendant. He took the meat home where it was prepared for the family's Sunday dinner and was eaten the day after its purchase. Sanguedolce, along with others, ate the product and they all became violently ill. The illness was diagnosed as trichinosis and an examination of the meat showed the presence of trichina larvæ. Sanguedolce claimed that the defendant sold meat intended for human consumption that was diseased and corrupted with trichina parasites, that it was wholly unfit for human consumption, and that the meat was sold in violation of the provisions of the Ohio Pure Food Laws. The defendant claimed that Sanguedolce was guilty of contributory negligence in that he failed to properly cook the meat before eating it.

The lower courts decided in favor of the defendant and Sanguedolce appealed the decision to the Supreme Court of Ohio. Of the several sections of the Ohio statutes involved, Section 12760 is particularly in point, it reads: "Whoever sells, offers for sale, or has in possession with intent to sell diseased, corrupt, adulterated, or unwholesome provisions without making the condition thereof known to the buyer shall be fined not more than $50 or imprisoned twenty days or both."

The Supreme Court in deciding this case held that the Statute places an absolute liability on the seller of meat infected with trichina without regard to knowledge of its presence. A violation of the statute therefore, is negligence *per se*. The court goes on to say that this places a heavy burden upon the seller but he may require a warranty from the person who sells the meat to him. The seller also has a measure of protection in the obligation of the purchaser and the consumer not to eat pork in an uncooked state. One who eats pork with the knowledge or means of knowledge that it has not been properly cooked is guilty of contributory negligence precluding a recovery from the seller of such meat.

In upholding the lower court's decisions in favor of the defendant, the Supreme Court held that the trial court properly charged the jury on the subject of contributory negligence.

### Kurth v. Krumme

### Decided by the Supreme Court of Ohio July 26, 1944

Frances Kurth, as administratrix of the estate of her husband, Walter Kurth, deceased, brought suit in the Court of Common Pleas of Summit County against Karl Krumme, claiming that the death of Walter Kurth was directly due to eating a preparation called "metwurst" which was purchased from Krumme. Mrs Kurth further claimed that the metwurst consisted in part of food that was unwholesome, diseased, corrupted, tainted or adulterated, and as such was unfit for human food.

Mrs. Kurth brought her action under the provision of the Ohio statutes relating to foods and their sale, particularly Section 12760, General Code, which provides "Whoever sells, offers for sale, or has in possession with intent to sell diseased, corrupt, adulterated, or unwholesome provisions without making the condition thereof known to the buyer shall be fined not more than $50 or imprisoned twenty days or both."

The lower court granted Mrs. Kurth a verdict and judgment was entered in the sum of $3,000. The Court of Appeals upheld this decision and Krumme appealed to the Supreme Court of Ohio for a reversal.

In reviewing the case, the Supreme Court held that pork infested with *Trichinella spiralis* is diseased within the meaning of the Ohio Pure Food Laws and the violation of Section 12760 of the General Code is negligence *per se*. Upon cross-examination Krumme, an aged man of German birth, testified that metwurst is prepared by chopping fresh pork shoulders and hams into small pieces and running the resulting product through a grinder. Spices are then added and the mixture is put into a casing. The product is then smoked and it is ready for sale. He said that the meat going into the metwurst is never cooked. Krumme further testified that it was common practice for the purchaser to eat the metwurst as it comes from the butcher shop without any further preparation.

It was plain from the evidence that the defendant and his family ate the metwurst without cooking and that it was so consumed by many people.

Krumme claimed that the lower court should have found Kurth guilty of contributory negligence in not cooking the metwurst thoroughly before consuming the product, and that being the case, should have decided the action in his (Krumme's) favor.

The Supreme Court in upholding the decision of the lower court in favor of Mrs. Kurth stated that "Under all the evidence we are of the opinion that contributory negligence was a question of fact and was properly submitted to the jury. Had defendant (Walter Kurth) eaten the raw shoulder or ham of pork as it came from the slaughtered animal, a different conclusion as to contributory negligence might be required."

Chapter

# 6

## PHYSICAL AND CHEMICAL CHARACTERISTICS OF MEAT AND THE PRINCIPAL ORGANS

THE structure and chemistry of muscle tissue, fatty tissue, and the principal organs of meat-producing animals are briefly considered in this chapter. The histology and chemistry of those tissues and organs are reviewed in a limited way. There is also a brief discussion of poultry anatomy.

**Histology.**—A knowledge of the structure of muscle tissue, fatty tissue, and such organs as the lymph glands, spleen, liver, lungs, kidneys, and mammary glands is basic in applying the principles of food hygiene to the production of meat and allied products.

**Skeletal Muscles.**—These are striated muscles which are under voluntary control and, for the most part, are attached to the skeleton. They also serve as voluntary sphincters and are found attached to the skin.

*Fibers.*—The functional unit of skeletal muscle is called a fiber. The fiber is really a large multinuclear cell. The fiber is the largest cell in the body ranging in length and thickness up to a size which is visible to the naked eye. Its greatest length is approximately 4 cm. and it ranges in thickness from 10 to 140 micra. The thickness of fibers varies somewhat in the same muscle but there is a more or less typical size for each muscle. There is some correlation between the kind of work a muscle performs and the thickness of its fibers. The fibers making up delicate muscles are much smaller than those of the bulkier muscles. As a muscle increases in size there is no increase in the number of fibers but rather in an increase in the size of its fibers.

Skeletal muscles are made up of muscle fibers held together by connective tissue and arranged parallel to each other. The fibers are combined to form primary, secondary, and tertiary bundles. The connective tissue surrounding the large bundles is called the epimysium. The connective tissue extending from the epimysium into the spaces between the bundles of muscular fibers is called perimysium. A thin, fibrous network called the endomysium continues from the perimysium to surround each muscle fiber. The type of connective tissue fibers making up the interstitial connective tissue varies according to the functional peculiarities of the particular muscle.

Completely surrounding the muscle fiber is a tough cell membrane called the sarcolemma. Inside the sarcolemma are the nuclei and the cross-striated substance composed principally of the myofibrils. There is also present the fluid sarcoplasm surrounding the myofibrils and accumulating

at the poles of the nuclei. The sarcoplasm corresponds to the cytoplasm of other cells. Stained sections of skeletal muscle are characterized by the peripherally placed nuclei and the cross-striations.

The striated muscle fiber is made up of colloid cross-striated myofibrils in a liquid sarcoplasm surrounded by a semi-permeable membrane, the sarcolemma, with numerous nuclei lying immediately under the sarcolemma.

*Myofibrils.*—The myofibrils give the fiber an appearance of longitudinal striation. They appear as long parallel threads which do not branch. Their thickness ranges from ultramicroscopic to as large as 1 to 2 micra.

The myofibril is composed of two main types of substances which alternate regularly along its length. These give the alternating light and dark areas which extend from one myofibril to another across the fiber giving the cross-striated appearance to the fiber.

*Cross-striations.*—The alternating light and dark areas or striations run the length of the fiber and are sometimes referred to as disks. The dark area is designated by the letter "Q" by some authors and "A" by others. The light area is designated by the letter "J" by those authors using the "Q" designation for the dark area and with the letter "I" by those using the "A" designation for the dark area. Through the light area runs a dark line or disk identified by the letter "Z". The amount of substance included between two "Z" lines is called a sarcomere. The sarcomere is considered to be the structural and functional unit of the skeletal muscle fiber.

There is no structural characteristic that would permit distinguishing the skeletal muscle fiber of one food-producing animal from that of another.

**Cardiac Muscle.**—This muscle is also cross-striated but is not under voluntary control. It consists of a network of interlacing muscle fibers which have anastomosing branches that fuse into a continuous syncytium.

Although the minute structure of the striated substance of cardiac muscle is essentially the same as that of skeletal muscle, the fibers making up these two classes of muscle tissue are quite different. The nuclei in the cardiac muscle fiber are always arranged in the interior of the fiber by contrast with the peripherally located nuclei in the skeletal muscle fiber. The myofibrils are similar to those in skeletal muscle and are composed of the same light and dark areas. The sarcoplasm is somewhat more apparent in the cardiac muscle fiber than in the skeletal muscle fiber. A very thin sheath surrounds the cardiac muscle fiber by contrast with the tough sacrolemma of skeletal muscle.

The intercalated disks in the cardiac muscle fiber also serve to distinguish it from skeletal muscle. The simplest form of this cross band runs parallel to and obliterates the "Z" line across an entire fiber. It may, however, extend across a fiber in a sort of a step formation with horizontal portions at different levels connected by slender, vertical lines. The intercalated disk is not so thick as a sarcomere ranging from 0.5 to 1 micron. The myofibrils are believed to pass uninterruptedly through these disks. Most authors do not believe that these disks are cell membranes. They appear comparatively late in the development of the cardiac muscle and their number increases with age.

Cardiac muscle has a richer blood supply than skeletal muscle.

**Purkinje Muscle.**—These muscle fibers make up a network under the endocardium which lines the internal surface of the heart particularly the interventricular septum. The fibers of this muscle tissue are a lot larger than those of cardiac muscle and, like cardiac muscle, the fibers are elongated bodies with blunt ends and characterized by intercalated disks. The fibers of this Purkinje muscle also form a network of anastomosing branches. These muscle fibers are very similar in design to cardiac muscle fibers. They have centrally located nuclei and peripherally placed striated myofibrils but the proportions of the components are different than in cardiac muscle.

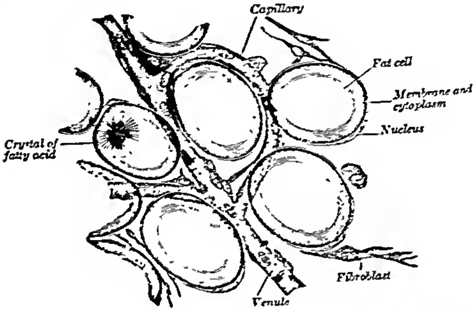


Fig. 53.—Cells for the margin of a fat lobule. (Sharpey-Schafer, Schafer's Histology Longmans, Green & Co.)

**Smooth Muscle.**—This is called non-striated, plain, or involuntary. It is not cross-striated as are the other three classes of muscle tissue and it is not under voluntary control. It is found primarily in the internal organs; it forms the contractile portions of the wall of the digestive tract from the middle of the esophagus to the internal sphincter of the anus. It also occurs in the ducts of glands connected with the intestine and in the respiratory passages from the trachea to the alveolar ducts and in the urinary and genital ducts. Smooth muscle also makes up to a considerable extent the walls of the arteries, veins, and some of the larger lymphatics. It is scattered throughout the connective tissue of the skin and of certain sensory organs and in the capsule and trabeculæ of the spleen.

Smooth muscle is made up of long, spindle-shaped cells each with a single, centrally located nucleus. Peripherally, the cell is made up of myofibrils which upon being stained show a faintly longitudinal striation. The myofibrils do not possess the alternating light and dark areas which give the cross-striated effect to the other three classes of muscle tissue.

The smooth muscle cell does not possess a distinct membrane which corresponds with the sarcolemma of skeletal muscle. The cells are so arranged that the thick middle portion of one cell which contains the nucleus is opposite the thin ends of several adjacent cells. Cross sections of smooth muscle show cells of varying thickness, therefore. A characteristic of smooth muscle is its intimate association with elastic connective tissue fibers. This has resulted in the description "myo-elastic" tissue by some authors.

**Fatty Tissue.**—Fatty tissue is usually considered as being a modified type of fibrillar connective tissue differing from loose connective tissue in that the cells have taken on large quantities of fat and have lost their fiber-forming capacity. Under the microscope each cell looks like a large droplet of fat surrounded by a thin film of cytoplasm which is thickened in that portion containing the nucleus.

Fat cells are found isolated or in groups in all loose connective tissue. In those locations where they are present in large numbers and are organized in groups or lobules, each lobule is surrounded by a layer of areolar connective tissue. Each cell in the lobule is surrounded by a delicate connective tissue stroma which contains numerous capillaries. The blood supply of fat is rich and the vascular supply of each lobule is complete and independent. An artery runs to each lobule where it breaks up into a capillary network surrounding the cells. This network in turn gives rise to the intralobular veins.

**Lymph Gland.**—Lymph glands vary considerably in size, they are usually oval or bean-shaped with an indentation on one side where the blood vessels and efferent lymphatic vessels leave the node. The afferent lymphatic vessels pierce the capsule of the lymph gland on the convex side. This capsule is made up of connective tissue which blends with the surrounding tissue to hold the organ in place. At the indentation or hilum, there is a depression where the capsule is thickened and extends deep into the gland.

The capsule gives off trabeculæ which extend into the substance of the gland. The arrangement of the trabeculæ and the lymphoid tissue elements is different in the outer or cortical part of the gland than in the inner or medullary part.

*The Cortex.*—The trabeculæ extend perpendicularly from the internal surface of the capsule to form the characteristic cortical compartments. These compartments consist of lymphocytes closely packed together to form cortical nodules which connect centrally with the cords of lymphoid tissue found in the medulla. The cortical nodules are usually made up of lighter staining central areas called germinal centers where the lymphocytes are formed. The surrounding areas stain darker because of the abundant supply of lymphocytes packed together.

Immediately under the capsule and between it and the cortical nodules are lymph sinuses into which the lymph enters from the afferent lymphatic vessels. From these sinuses the lymph flows centrally passing around the nodules to enter the sinuses of the medulla.

*Medulla.*—The medulla differs from the cortex in cell arrangement rather than in cell components. The trabeculæ as they extend into the medulla are quite irregular and anastomose frequently. The masses of lymphocytes do not form nodules as in the cortex but appear as anastomosing cords

called lymph cords. Lymph sinuses are numerous in the medulla separating the lymph cords from the trabeculæ. The efferent lymphatic vessels which leave the lymph gland at its hilum arise from the medullary sinuses.

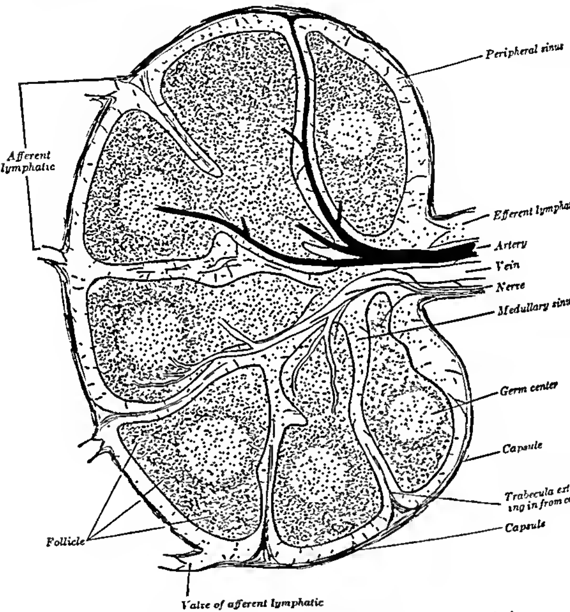


FIG. 54.—Diagram of a typical lymph gland. × about 20. (Cowdry's Textbook of Histology.)

Except for arrangement, the component parts of the lymph gland, namely, the lymphoid tissue, sinuses and trabeculæ have a similar relation throughout the gland.

The foregoing description of a lymph gland applies to the glands of all mammals but swine. The arrangement of the various tissues that make up the lymph glands of swine is virtually the reverse of that found in other mammals.

**Spleen.**—This organ is the largest concentration of lymphoid tissue in the body. It differs from a lymph gland, however, since it is not interposed in the flow of lymph but is inserted in the bloodstream. It has no afferent lymph vessels and no lymph sinuses as do lymph glands. Its sinuses are venous sinuses filled with blood.

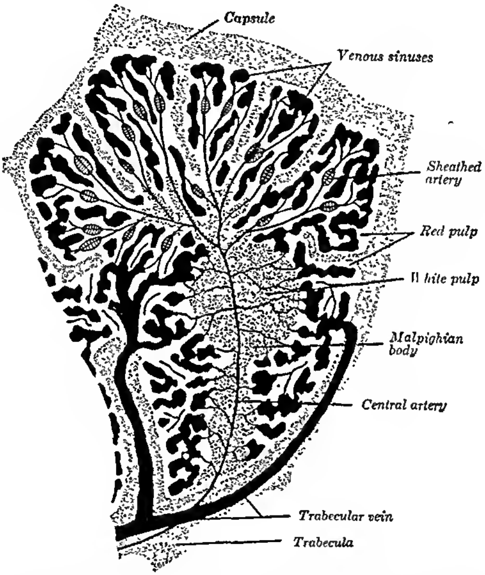


FIG. 55.—Diagram of a complete lobule of the spleen. (Redrawn and modified from Maximow-Bloom's Histology, courtesy of W. B. Saunders Company.)

The spleen is covered by a thin capsule of fibrous tissue containing numerous elastic fibers and some smooth muscle tissue. There is a thickening of the capsule at the hilum of the spleen where the blood vessels enter and leave it.

Numerous trabeculæ extend from the hilum and the capsule to form the framework of the organ and divide it somewhat imperfectly into lobules. The splenic tissue which fills these lobules consists of characteristic lymphatic tissue referred to as white pulp and antypical lymphatic tissue called red pulp.

The arteries and veins follow the trabeculæ as they enter and leave the lobules.

*The White Pulp.*—As the branched artery leaves the trabeculæ to enter the lobule, it is surrounded by a stroma of lymphatic tissue which constitutes the white pulp.

*The Red Pulp.*—Between the white pulp and the venous sinuses is the red pulp which appears as a continuation from the white pulp of a modified lymphatic tissue. It is made up of a framework of reticular fibers containing in the meshes of its framework many lymphocytes, free macrophages and all the elements of the circulating blood.

Authorities disagree on the manner in which the blood passes from the artery to the venous sinuses. There are three main theories: (1) The blood corpuscles flow from the terminal capillaries into the intercellular spaces passing slowly through the red pulp and eventually entering the venous sinuses through its walls. (2) The arterial capillaries connect directly with the venous sinuses. (3) A combination of theories 1 and 2, that both types of circulation exist at the same time.

The venous sinuses which have wide, irregular lumina and whose size varies greatly are the beginning of the venous system in the spleen. They empty into veins which consist only of endothelium supported by the connective tissue of the trabeculæ. These veins follow the trabeculæ and as they proceed toward the hilum they combine to form the splenic veins.

The spleen filters the blood very much the same as the lymph nodes filter lymph.

**Liver.**—The liver is a compound tubular gland, the functioning units or lobules of which do not depend on a duct system but on a distribution of blood vessels that bring to it a double blood supply. The lobules are small, polygonal prisms 0.5 to 2 mm. in diameter, their height being roughly twice their diameter.

*Lobule.*—At the core of each lobule is a central vein which drains blood from it. The blood enters this central vein from intralobulary capillaries which are sinusoidal in form and occupy the spaces between the cords of liver cells which assume a radial position from the central vein to the periphery of the lobule. These hepatic sinusoids receive blood from the capillaries arising from the branches of the portal vein and the hepatic artery which lie in the connective tissue that separates and marks off the lobules. The blood carried from the liver by the hepatic veins originates in the central veins.

A network of bile capillaries also permeates the lobule running the length of the cords of liver cells in close proximity to them and extending between the sides of adjoining liver cells. These bile capillaries are also called bile canaliculi and they frequently anastomose with one another but are always intercellular. The flow of bile in the bile canaliculi is toward the periphery of the lobule in contrast with the flow of blood in the lobule which is towards its central vein. The bile flows into the interlobular bile duct which lies in the interlobular connective tissue. An interlobular bile duct collects the bile from several adjacent lobules.

*Liver Cells.*—Liver cells, also called hepatic cells occur in what are referred to as cords that extend radially from the central vein to the periphery of the lobule. These cords branch and anastomose with each other being separated laterally from each other by the hepatic sinusoids. The

liver cells, which do not differ materially one from the other, perform all of the multiple and diverse functions of the liver with the exception of that performed by the Kupffer's cells.


FIG. 56.—Reconstruction of a liver lobule of the pig. (From Bailey's Histology, after Braus, Anatomie des Menschen, Williams and Wilkins and Julius Springer.)

*Kupffer's Cells.*—These are fixed macrophages in the lining of the hepatic sinusoids. These cells pick up foreign substances from the blood as it passes through the sinusoids and store them in their cytoplasm.

**Kidney.**—The kidney is a compound tubular gland which serves the general function of stabilizing the composition of blood, ridding it of

nitrogenous wastes and undesirable salts through a process of filtration. Along with the skin and lungs it helps to maintain the constant volume of the blood by eliminating excess water which serves as the filtrate. Depending on the needs, a portion of the filtrate is reabsorbed. That which is not reabsorbed is excreted as urine.

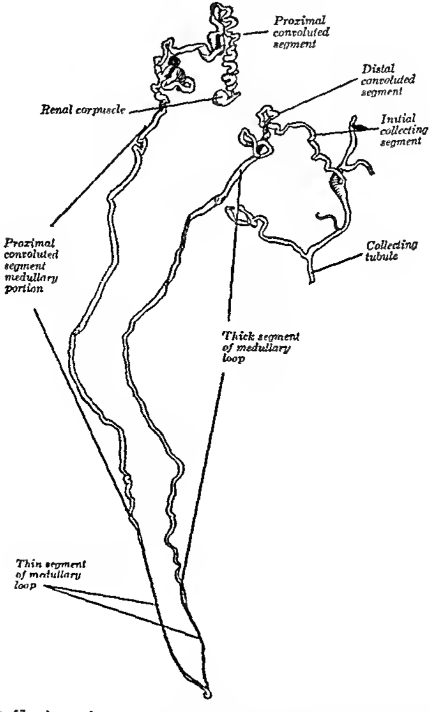


FIG. 57 – A complete renal unit (nephron) isolated by maceration from a normal kidney × 15 (Redrawn in Cowdry from Oliver and Lund, courtesy of Arch. Path.)

In the side of the kidney toward the median line of the body is a large depression called the hilum which leads to a large cavity or sinus. The sinus is filled with loose, connective, and fatty tissue through which the vessels and nerves pass to the renal tissue. It contains the renal pelvis which is an enlargement of the excretory passages of the kidney.

The sinus is surrounded by glandular kidney tissue which is made up of cone-shaped structures called renal lobes.

*Renal Lobe.*—The apex of the cone-shaped renal lobe fits into a minor calix of the pelvis and contains the discharge ends of the urinary collecting tubules. Each lobe consists of a medullary portion characterized by striations radiating from the apex of the cone and a cortical portion which forms the base of the cone bounded by the capsule of the kidney. The renal lobe is composed of glandular tissue and tubules that are made up of the nephrons which are the functional units of the kidney, and the urinary collecting tubules.

*Nephron.*—This consists of a renal corpuscle with its tubule. The presence of the renal corpuscle and the convoluted tubules of the tubular portion of the nephron in the cortical portion of the lobe gives it its characteristic appearance. The medullary portion of the lobe gets its radiating striated appearance from the fairly straight ascending and descending portions of the tubules of the nephron and from the urinary collecting tubules.

In the renal corpuscle is a mass of arterial capillaries called the glomerulus. This tuft-like capillary network lies in the invaginated expanded end of the tubule. This forms a two-layered capsule making up the renal corpuscle. Both the afferent and efferent vessels of the capillary network are arterioles. Each tubular secretory portion begins with the renal corpuscle and ends at its junction with the excretory ducts. As the tubule leaves the renal corpuscle, it forms the proximal convoluted segment which follows a very tortuous course. From here the tubule descends as a comparatively straight medullary portion forming a loop at its farthest end in the medulla, continuing to ascend as another comparatively straight portion through the medulla to the cortex where it forms the distal convoluted segment from which it proceeds to the urinary collecting tubule. This tubule then descends through the medulla, picking up other tubules on the way to discharge at the apex of the lobe into the urinary pelvis.

**Lung.**—The trachea as it enters the thoracic cavity divides into bronchi which enter the lungs at each hilum. As these bronchi enter the lungs they possess the same general structure as the trachea, but soon after they enter the lungs the cartilage rings are replaced by irregularly shaped plates of cartilage which completely surround the bronchus. The bronchus is also completely surrounded by a muscular layer. These bronchi divide into smaller bronchi and these in turn divide into bronchioles.

*Bronchioles.*—As the diameter of the bronchioles reaches approximately 1 mm. the cartilage disappears entirely and they are surrounded by an interlacing mesh of smooth muscle intimately associated with elastic fibers. Most authors divide the bronchioles into two classes: (1) Those forming the terminal part of the air-conducting system of tubules, and (2) the respiratory bronchioles formed by branching of the terminal conducting

bronchioles. The first class is, as the name implies, entirely air-conducting tubules, while the respiratory bronchioles are characterized by the budding of a few alveoli from their sides.

The successive divisions of the bronchial tree are: primary bronchi, secondary bronchi, bronchioles, terminal bronchioles, respiratory bronchioles, alveolar ducts, alveolar sacs, and alveoli.

*Alveolar Sacs and Alveoli.*—The respiratory bronchioles branch and these branches radiate cone-like into several alveolar ducts. Each duct extends for some distance as thin-walled tubes following a tortuous course with some branching. Along these ducts occur the closely set out pouchings which constitute the alveolar sacs. These sacs are blind, thin-walled, and polyhedral, closely packed one against the other. The openings into the sacs form the greatest part of the wall of the alveolar duct. In addition to alveolar sacs, single alveoli also occur as out pouchings from the alveolar ducts. The wall of the alveolar sacs consists of several out pouchings forming the alveoli.

The capillaries in the alveolar walls are numerous and anastomose freely filling up entirely the space between adjoining alveoli. Occurring along with the branching capillaries is a closely meshed network of branching reticular fibers which support the thin-walled alveoli and their numerous capillaries. A number of elastic fibers are also present in this network. There have been demonstrated openings or pores through the walls separating the alveoli which permit them to communicate with one another. There is some controversy concerning the nature of the cell structure lining the alveoli. Whatever its structure there is little tissue between the capillaries and the alveolar gases.

considerably in size. The appearance of ducts and alveoli is not uniform throughout the gland, varying considerably in different stages of functional activity. The secretory lining of the alveolar ducts and the alveoli consists of basement membrane, a layer of myo-epithelial cells with a row of low columnar glandular cells lining the internal surface.

During secretory activity, the low columnar glandular cells become elongated and swollen and minute droplets of fat appear in their protoplasm. These unite to form several large droplets toward the free end of the cell from which they are discharged into the lumen of the duct or alveoli. The free end of the cell itself also becomes detached into the lumen from the basal nuclear position. The remaining glandular cell is low cuboidal in shape and soon regenerates its lost protoplasm to repeat the secretory process.

**Chemistry.**—The chemical composition of animal tissues has been examined both with respect to their physiological functioning and their nutritive and commercial value. Chemical analyses and determinations made in this connection furnish information which is useful in gaining an understanding of the composition and reaction of animal products as they are handled and prepared as articles of human food.

**Muscle Tissue.**—More work has been performed on the chemistry of striated muscle than on smooth muscle. For the purposes of meat hygiene the composition of striated muscle tissue has considerably more significance since meat consists of this class of muscle tissue. Approximately 75 per cent of water and 25 per cent of solids make up striated muscle. Approximately $\frac{4}{5}$ of the solids consists of protein with the remainder being made up of "extractives" and inorganic solids. According to Mitchell, the protein content tends to be higher in smooth muscle than in striated muscle.

*Muscle Proteins.*—Myosin 67 to 68 per cent, globulin X 21 per cent, myogen 10 per cent, myoalbumin 1 per cent, muscle hemoglobin (in red muscle) less than 1 per cent. Myosin is the most thoroughly studied of all the muscle proteins. It is the major, if not the only protein of the myofibril and is, therefore, considered to play a major role in muscle contraction. It has been found to possess enzymatic properties which enter into the metabolism of muscle tissue that supplies an important part of the energy of contraction. There appears to be some uncertainty, however, as to whether the myosin molecule actually possesses enzymatic properties itself or whether such properties are adsorbed on the molecule.

Myosin undergoes a type of denaturing during rigor mortis when it coagulates and becomes insoluble; this causes the characteristic stiffness of rigor mortis. Mirshky and Anson have shown that there is a change in the sulfhydryl and disulphid groups when proteins are coagulated by denaturing agents, such as heat and acid. Myosin coagulation in rigor mortis is not accompanied with any change in its sulfhydryl and disulphid groups. The coagulation of myosin in rigor mortis appears to resemble its process of coagulation as demonstrated by Mirshky when caused by dehydration. During this process it loses solubility without any change of its sulfhydryl and disulphid groups.

Globulin X, myogen, and myoalbumin appear to be proteins of the sarcoplasm.

tributes to muscle metabolism, myoglobin takes on oxygen reversibly without changing its iron atom from the ferrous to the ferric form. This combining of myoglobin and oxygen has been called oxygenation and forms oxymyoglobin. The myoglobin readily gives up its oxygen when the oxygen pressure is lowered within the cell. Millikan describes this by saying that the activity of myoglobin for oxygen to form oxymyoglobin lies between that of hemoglobin and the oxidases so that it is well adapted to taking up oxygen from one and give it to the other.

Myoglobin may be actually oxidized to form a brown-colored product called metmyoglobin which has its iron in the ferric condition. Oxymyoglobin and metmyoglobin contain the same amount of oxygen, but the latter does not lose its oxygen when the pressure is reduced.

According to Millikan, myoglobin is more easily oxidized to the met form than hemoglobin. Hemin catalysts probably owe their activity to their easy alteration between the bivalent and trivalent states. Myoglobin in this property is more like an enzyme than is hemoglobin. He finds that it appears to be a half-way station or connective link between oxygen carriers and oxygen catalysts.

Myoglobin also reacts with many other compounds such as carbon monoxide, nitric oxide, hydrogen sulfide, and ferri cyanide.

The myoglobin content of beef muscle has been found by various investigators to range from 2.26 to 5.41 mg. of myoglobin per gram of fresh tissue. The myoglobin content of pork muscle has been found to range from 0.79 mg. of myoglobin per gram of fresh tissue in light-colored pork tissue to 1.44 mg. in dark-colored pork tissue.

The stable pink pigment of unheated cured meat is nitric oxide myoglobin. When heated this produces another stable pink pigment called nitric oxide myochromogen. In the presence of oxygen, the nitric oxide is lost from the pigment. This oxygen uptake is associated both with the oxidation of the nitric oxide and with the oxidation of the protein part of the pigment molecule. This oxidation of the myochrome results in darkening of the pigment and it loses it ability to reform the nitric oxide derivative which is the desirable pink pigment.

*Cytochromes.*—These are mentioned because they are also iron-porphyrin proteins consisting of a combination of globin and reduced heme. Three cytochrnmes, a, b, and c, have been identified by their distinct absorption bands. Cytochrome c is the only one that has received satisfactory chemical investigation. Mitchell states that it is now believed that one or more of the cytochromes can be found in every cell which respires aerobically and that nearly all the respiratory activity of such a cell depends on them. According to Millikan, all active muscle tissue contains considerable amounts of cytochrome whether it contains the muscle hemoglobin or not, however, in red muscle, muscle hemoglobin may have a concentration 50 times that of cytochromes. Theorell describes cytochromes as exercising their effect through the oscillation of the valency of the iron from ferrous to ferric. Since electrons are received from one quarter and given off to another, cytochromes transport a stream of electrons leading from hydrogen-transferring enzymes toward molecular oxygen.

*Extractives—Nitrogenous.*—The extractives in this class are believed to

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*Extractives—Nitrogenous.*—The extractives in this class are believed to

give meat its flavor. They include creatine, phosphocreatine, purine bases, adenylic acid, carnosine, anserine, inosinic acid, uric acid, and carnitine. In addition to these, others have been described and still others are probably present but so far have not been detected. Many are produced largely by post-mortem reaction and are not present as such in significant amounts in living tissue.

*Non-nitrogenous.*—Glycogen is the principal carbohydrate of muscle tissue and according to Mitchell constitutes up to 1.5 per cent in mammalian striated muscle. Glycogen content may be very nearly exhausted by intense muscular activity. The amount of glycogen in the muscle tissue is not significantly reduced by carbohydrate demands elsewhere in the body. Muscle tissue does not serve as a storage place for glycogen.

Hexosephosphate, lactic acid, inositol and fat make up the other principal non-nitrogenous extractives.

A large number of enzymes are present in muscle tissue. Some have received a considerable amount of attention in connection with the study of the phenomena of muscular contraction. Some have been identified with post-mortem changes. Others have not been well characterized.

Meat is a good source of some but only a fair source of others of the B group of vitamins. Meat is a fair source of ascorbic acid but does not contain significant amounts of fat soluble vitamins.

*Inorganic Salts.*—Potassium is the predominant cation in muscle tissue. Other cations are sodium, magnesium and calcium. Phosphate is the principal anion and is probably, for the most part, tied up in adenosinediphosphate (ADP) adenosinetriphosphate (ATP) and phosphocreatine. The free inorganic phosphate found on analysis according to Hawk, Oser, and Summerson may have been produced by the decomposition of ATP and phospocreatine. Other anions are chloride and traces of sulfate.

*pH of Muscle Tissue.*—The resting muscle is neutral but becomes acid after death due to the production of lactic acid. The lactic acid is produced at the cost of the glycogen content of the muscle at the time of death. Accordingly, the degree of acidity depends on the amount of glycogen and it is also self-limiting since the enzymatic action becomes retarded at or a little below pH 5.4. As a practical matter, it is unusual for muscle to contain sufficient glycogen to produce a pH as low as 5.4.

Actually, it is difficult to evaluate the exact pH of muscle at the time the animal is slaughtered and immediately prior to cessation of circulation. It depends on the history of muscular activity. The lactic acid content of muscle functioning aerobically will be very low. It is probable that the pH of a muscle at the time of slaughter is in the neighborhood of 7.4.

While the degree of change in pH of muscle tissue after death has a profound effect on the physical properties of the proteins making up the fibrils, it is not considered to be the principal factor in the development of rigor. Rigor has been demonstrated to set in without any change in pH whatever and appears to be associated with the disappearance of ATP (adenosinetriphosphate) in the muscle tissue. The difference in physical characteristics possessed by meat of high pH and meat of low pH is related to the condition of the substance of the fibrils making up the muscle tissue. Associated with high pH is a closeness of structure

with the fibrils lying closely packed along the grain of the meat. There is an openness of structure associated with a low pH brought about by a shrinking of the substance making up the fibrils.

This closeness of structure of the muscle tissue in meat of a high pH produces the so-called dark cutting of beef. This deep, dark red color is explained as resulting from the light being reflected through a deep layer of pigment. The actual amount of pigment present in the meat does not vary with the pH. The paler red color of light cutting beef is considered to be due to the scattering of the light by the more open structure of the superficial layers in meat having a low pH.

The other characteristics associated with differences in pH and related to the structure of the fibrils have to do with salt penetration, and the effect of heating on the moisture content of the meat. Meat of high pH because of the closeness of the structure does not take on salt in the curing process as readily as meat of low pH.

Bacterial growth has been found to be more vigorous on meat of high pH than on meat of low pH. The growth of bacteria on meat of high pH is more abundant because of the lack of acidity rather than the closeness of structure of the muscle tissue.

**Connective Tissue.**—*White fibrous.*—According to Gies and his associates there is 62.9 per cent water in white fibrous connective tissue and 37.1 per cent solids. The albuminoid collagen makes up 86 per cent of the solid constituent, elastin 4.5 per cent (also an albuminoid), and the glycoprotein tendomucoid 3.5 per cent. The remaining solids are described as ether-soluble material, "extractives", and inorganic matter.

Collagen is insoluble in all reagents which do not change it. It is not soluble in the usual protein solvents. Collagen has the property of being converted to gelatin by boiling water. This appears to be largely a physical alteration. Gelatin differs from collagen in being easily soluble and digestible. Collagen is digested by pepsin-hydrochloric acid and also by trypsin at temperatures above 40° C. but best by successive action of both enzymes.

*Yellow elastic.*—This class of connective tissue is made up of 57.6 per cent water and 42.4 per cent solids. By contrast with white fibrous connective tissue, elastin makes up 75 per cent of the solid constituent of yellow elastic connective tissue with collagen 17.1 per cent, and tendomucoid 1 per cent. The composition of the remaining solids is similar to white fibrous connective tissue.

Elastin resembles collagen in that it is insoluble in protein solvents, however, it is not changed to gelatin by boiling water. Elastin is digested slowly by pepsin and trypsin but differs from collagen in amino acid composition.

**Fatty Tissue.**—According to Winton, the walls of fat cells consist of elastin or a similar substance. The connective tissue stroma supporting the fat cells consists of a mingling of collagenous fibers with elastic fibers varying in their relative amounts according to their location in the body.

Animal fats from various sources differ considerably in their fatty acid content. Animal fats as they occur naturally are mixtures of individual fats and consist for the most part of mixed glycerides of oleic, palmitic, stearic, linoleic, and myristic acid. Lard also contains small amounts of

highly unsaturated $C_{20}$ and $C_{22}$ acids, traces of which are also reported as occurring in beef and mutton fats. Animal fats derived from internal tissues, such as kidney and abdominal fats, are harder and less unsaturated than those from tissues near the skin.

**Poultry.—The Respiratory System**—The anterior naris may be guarded by small feathers and is elliptical in outline with the long access anterio-posterior. There are two nasal cavities separated from each other by a bone and cartilage septum. Each nasal cavity connects with the pharynx through the palatine cleft and a posterior naris. The larynx is not guarded by an epiglottis. The organ of voice in the bird is not located in the larynx. The larynx opens into the trachea which divides posterially in the vicinity of the opening to the thorax into two bronchi. At this point of bifurcation is located the caudal larynx (syrinx) which is the voice organ.

The two bronchi continue the air passage into the lungs. The respiratory system of the fowl includes not only the lungs, but also the air sacs. These air sacs connect directly with the primary and secondary bronchi and extend widely throughout the body cavity, as well as into certain of the cervical and thoracic vertebrae, the bones of the shoulder girdle, the humerus, sternal ribs, sternum, sacrum, and pelvic bones, and the intermuscular spaces of the shoulder. The lungs proper extend from the first ribs to the anterior ends of the kidneys. The ventromedial surface is covered in part by the pulmonary diaphragm, while the dorso-lateral surface is deeply grooved by the ribs. The lungs are not divided into lobes as in many mammals, but distinct lobules are formed about the terminal loops of the tertiary bronchi. The lungs from normal birds show considerable elasticity, are pink in color, and are very light in weight.

**The Digestive System.**—The lining membrane of the mouth cavity is similar to that of mammals. Many posteriorly directed papillae are present in the mucosa of the hard palate which presents a median cleft. The mucous membrane of the tongue is uneven and devoid of papillae except posteriorly where there is a transverse row. The dividing line between the mouth and the pharynx is usually considered to be marked by the posterior-most transverse row of palatine papillae and the row of papillae on the base of the tongue.

The structure of the esophageal wall is similar to that of mammals. The crop of the duck and the goose is merely the spindle-shaped cervical portion of the esophagus which dilates to store the food until it can be handled by the gizzard. The crop in chickens and turkeys is a thin-walled sac arising from the esophagus. Its lining is normally grayish or pinkish white with a pebbly surface. Although the crop naturally has the odor of the feed and mucous secretion, the normal odor is not offensive. In the lower esophagus there is a gradual transition between the crop and the proventriculus from the characteristic mucous glands of the esophagus to type found in the proventriculus.

The proventriculus of birds is a thick-walled, spindle-shaped, dilation of the esophagus located between the crop and the gizzard. It is analgous to the stomach of other animals. Its lumen is scarcely larger than that of the esophagus and its storage capacity therefore is limited. Even so, it is the glandular stomach of common fowl.

The proventriculus opens directly into the gizzard which is a heavy muscular organ with a tough keratinized lining. The muscles are a very deep dark red with a purplish sheen. The fat covering the gizzard and the proventriculus is characteristic. The duodenal and esophageal orifices are quite close together on the antero-dorsal surface of the organ.

The intestine of fowl although similar to that of mammals differs markedly in some parts. The duodenum which does not have glands of Brunner presents a loop supporting the pancreas and is generally considered to terminate at the entrance of the bile and pancreatic ducts. The jejunum and ileum are supported by a mesentery and bounded by air sacs which separate them from the abdominal wall. The intestines are normally filled with feed and in the upper part are of a pinkish color on the outside surface.

Beyond the small intestine, the bowel presents two retrograde portions called the ceca and a continuing portion. The paired ceca extend anteriorly for some 9 inches parellel to the ileum to which they are attached by peritoneal folds. These blind pouches are usually dark in color due to the nature of the fecal contents. The portion of the bowel between the cecal orifices and the beginning of the cloaca has been variously designated as large intestine, colon, and rectum. Its structure resembles that of the small intestine.

The cloaca is the structure into which the intestinal, genital, and urinary tracts empty. It is located just in front of the vent through which it voids. It is a pale, egg-shaped structure when filled and normally contains both urinary and intestinal excretement. The cloaca is usually delimited into three portions by circular folds. They are anterio-posteriorly, the coprodaeum, the urodaeum, and the proctodaeum. The urodaeum receives the ureters and genital tubes. The wall of the cloaca is structurally similar to that of the small intestine.

**The Liver.**—Microscopically, the liver of fowl varies little from the liver of mammals. The normal liver of fryers and broilers has a uniform deep red color and it is of a firm, uniform consistency. In normal fryers and broilers of the same size the livers are also remarkably uniform in size and color. The livers of normal, older fowl may, however, vary markedly in color and consistency. Normally the livers of fat fowl are soft and break readily. They may vary in color from dark red through pale yellow to milkish white, depending upon the character of the feed and amount of fat in the liver. In old roosters the livers are normally firm with a deep red color. The livers of normal turkeys are darker and firmer than the livers of normal chickens.

**The Kidneys.**—The kidneys of fowl are usually a deep red and lie in the bony structure of the back. They usually present three lobes of unequal size. They extend from the lung anteriorly back through the length of the pelvic cavity filling in the fossae formed by the pelvic bones and the vertebrae. The ureters run from lobe to lobe and terminate in the dorsal wall of the urodaeum of the cloaca. Microscopically, the structure of the kidney of the fowl resembles very closely that of the mammalian organ.

**The Reproductive Organs.**—The testes are intra-abdominal organs in fowls. These organs vary from the size of a grain of wheat in broilers to

kidney-bean shaped structures 1 to 2 inches long in mature cocks. Each testes is ellipsoidal and is suspended by the mesorchium ventrally to the anterior lobe of the corresponding kidney. Pigmented areas are sometimes present in the testes.

The ovary may vary in size from a small pinkish structure in the young females to a large mass of pendulous yolks in various stages of development in the mature bird. The oviduct likewise varies from an almost imperceptible structure extending along the lower surface of the backbone from the ovary to the cloaca, to a voluminous pinkish-grey or white structure with soft, thick walls. Normally only the left ovary and oviduct develop in birds.

**The Organs of the Blood Vascular System.**—The heart of birds is similar to that of mammals. It is a muscular organ and in commercially killed birds it usually has considerable fat at the base and a band of fat located spirally around its mid portion. As in mammals the heart is contained in a pericardium.

The arterial and venous systems are comparable to those of mammals. There are many differences in detail, but the similarity is attested to by almost identical terminology used for both systems.

**The Lymphatic System.**—Lymph glands are completely absent in the domestic fowl. Lymphoid tissue, however, is normally present in the substance of certain of the body tissues. Valves are present in the lymphatics of fowl but are relatively few in number and appear to be rather loosely arranged. They are, however, efficient to prevent retrograde flow.

With very few exceptions the lymphatics follow the courses of blood vessels being closely applied to the walls of these vessels. Where an artery and a vein have a common course outside the body cavity, the lymphatics usually follow the vein, but if the courses of a corresponding artery and vein are widely separated, lymphatics follow both vessels. Within the body cavity the lymphatics mainly follow the arteries.

**The Spleen.**—This organ is normally a deep bluish-red color or less frequently a deep red. It may vary considerably in size and still be normal. It is oval or somewhat disc-shaped and lies back of the liver and gizzard near the vertebrea.

Chapter

# 7

# FACILITIES RELATING TO SANITATION IN PLANT OPERATION

This chapter deals with the physical aspects of the packing plant and its premises, the plant equipment, and facilities generally as they have a bearing on environmental sanitation. The cleanliness and wholesomeness of meat including meat of poultry bear a direct relation to the kind of facilities that make up its environment.

**Water Supply.**—The characteristics of good quality in drinking water are epitomized in the 1941 Manual of the American Water Works Association as "A water supply should be clear, of neutral taste, of reasonable temperature, neither corrosive nor scale-forming, not so mineralized as to produce unfavorable physiological effects, and containing no organisms capable of producing intestinal infections."

A meat packing plant requires an abundant water supply. Since such uses as are connected with cooling compressed ammonia in the refrigeration system, washing hashed inedible offal preparatory to inedible rendering, and condensing vapors discharged from inedible rendering tanks might be accomplished with non-potable water, meat packing plants frequently have a non-potable water system as well as a potable one. The potable water system meets the standard of quality for drinking water. The distribution of the non-potable supply is such as to preclude its contaminating the potable supply or edible products.

**Standard of Quality.**—Four considerations enter into determination as to whether a water supply is acceptable as potable for use in the edible products departments of meat packing plants. They are the source of the supply, the water's physical characteristics, its bacteriological pollution, and its chemical pollution. A potable water supply is evaluated in terms of limits of permissible impurity.

*Source.*—When the potable water supply of the meat packing plant is obtained from a municipality it is generally a safe supply and the principal concern is to maintain its safety during its distribution and use in the plant.

The source of a private supply is examined and evaluated to exclude the probable sources of pollution.

Deep-seated or artesian waters, except those from fissured rocks usually contain few bacteria. Waters in limestone and fissured rocks often carry pollution for many miles. Dug wells, or shallow wells in surface deposits, even though in fine-grained material, may be polluted by surface waters through rifts, crawfish holes, or other direct channels. Accordingly, areas

around such wells require protection for considerable distances. The tributary area around such a well is widened by increased draft.

Ground waters as a class have great solvent power and are therefore usually hard and highly mineralized. The most common dissolved minerals are salts or calcium, magnesium, sodium, iron, and silica. The most common dissolved gases are carbon dioxide and sulphureted hydrogen.

On page 495 of the Appendix is reproduced the form used by the Federal Meat Inspection Service in obtaining information concerning private wells. The depth of the well, whether it is drilled or dug and the size of the well bore is considered in relation to the nature of the soil strata, and the location of the well with respect to buildings, livestock pens, sewers, and the like. The proximity of the well to such surface water as streams, rivers, ponds, and swamps is significant. The location of the well as to whether it is on low or high ground and whether the slope of the ground is toward it or away from it are of importance as they concern the probability of pollution by surface waters. The height of the top of the casing with respect to the ground level also has significance with respect to possible surface water contamination. The effects of rains and seasonal changes on the well water are indicative of the character of the tributary area.

*Physical Characteristics.*—Turbidity does not exceed 10 (silica scale). Turbidity of water results from finely divided suspended material. Measurement of turbidity is based on the optical obstruction of light rays passed through a sample when compared, under the same conditions, with an arbitrary standard turbidity scale. The standard unit of turbidity is that produced by one part per million of silica in distilled water.

Color does not exceed 20 (platinum-cobalt scale). Similar to the measurement of turbidity, an arbitrary standard scale is used as a means for comparison of color intensity with the water sample. The fact that a water possesses a color of 20 units means that the intensity of the color of the sample is equal to the intensity of the color of distilled water containing 20 milligrams of platinum (as potassium chlorplatinate) per liter. Waters usually vary from colorless to deep brown. Color in natural water is found generally to be due to the presence of tannin in solution (from decayed vegetation) or from various industrial wastes.

The water is free from odor of such substances as hydrogen sulfide or chlorine. Also, the water contains no odor caused by the presence of microorganisms. Odors traceable to the presence of microorganisms usually fall within three groups: Aromatic, caused by diatomaceæ and a few protozoa; grassy, caused by cyanophyceæ and chlorophyceæ; and fishy, caused by chlorophyceæ, diatomaceæ, and protozoa.

*Bacterial.*—The vast majority of bacteria found in drinking water supplies are entirely harmless and regulations designed to insure freedom from disease-producing bacteria are, accordingly, concerned more with the character than the numbers of bacteria present.

Since practically all of the diseases known to be commonly transmitted through water are due to organisms which are discharged from the intestines of infected persons, pollution with intestinal discharges is not only the most offensive but by far the most dangerous to which water supplies are exposed. Typhoid fever organisms, so far as known, develop only

in the bodies of infected persons and are discharged in the feces and urine. Tests for bacteria of the B. coli group afford a direct measure of the numbers of intestinal bacteria present. Since typhoid bacilli are found only in association with intestinal discharges, these tests have the most sanitary significance of any that can be made in a laboratory.

All water, whether taken from surface or underground sources, has at some time since its precipitation been in contact with the surface of the earth and has consequently been more or less exposed to pollution with intestinal discharges of persons and lower animals upon its catchment area. Between the sources of pollution and the ultimate destination of the water are numerous agencies operating to reduce the number of typhoid bacilli and other intestinal bacteria which may reach the consumer. It is obviously desirable that drinking water be at all times entirely free from such offensive and dangerous pollution, but it would be both impracticable and unnecessary to enforce a requirement that water be entirely free from bacteria of the B. coli group. The limit of permissible pollution contemplated in the following standard of bacteriological quality is as rigid as it can be made without requiring absolute freedom from such bacteria. Starting with Item 4 "Samples" on page 190 through Item 9 on page 199 of the 9th Edition published in 1946 of the "Standard Methods for Examination of Water and Sewage" which is prepared, approved, and published jointly by the American Public Health Association and the American Waterworks Association, is the accepted method for water examination for bacteriological contamination. A reprint appears on page 488 of the Appendix. Beginning on page 494 of the Appendix is an excerpt from Reprint No. 2679 from the Public Health Report of March 15, 1946 which relates the findings obtained from applying the standard method for *water examination to the 1946 Public Health Service Drinking Water* Standard.

*Disinfection Methods.*—Every effort is made to obtain a potable water supply without using a disinfection method when a private supply is used. The source of the private water supply is examined carefully to detect any probable contamination from surface waters. Also, the storage and distribution systems in the meat packing plant are gone over thoroughly to make sure that there is no point where the water is being contaminated. When all probable sources of contamination have been eliminated and the water supply does not meet the bacteriological test, then a disinfection method, usually chlorination is used.

*Chlorination.*—Although chlorination is used to obtain reduction in the bacteria content of water, it also has the side effect of oxidizing organic matter and certain minerals. It may even correct certain odor defects in a water supply. In recent years, ammonia gas has been used in combination with chlorine. The two used in combination give better results than chlorine alone.

The quantity of chlorine required for effective bacteria reduction is determined solely by the "chlorine demand" of the water. Sufficient chlorine must be added to satisfy the demands of the readily oxidizable components in solution and other materials which possess capacity for absorbing chlorine in one way or another. There must be sufficient addi-

tional chlorine added to provide some residual chlorine over and above this chlorine demand so that it may act as a germicidal agent.

Once the minimum residual chlorine required for the destruction of bacteria has been determined by bacteriological check, and that amount above which chlorine taste appears has also been determined, control of the amount of chlorine added to the water may be arranged so as to keep safely within these limits.

There is evidence to show that chlorination causes bacteria to completely disappear by the process of lysis. In pasteurization, for example, the dead bacteria may be found after the process, whereas, after chlorination none are revealed on microscopic examination.

*Ultra-Violet Ray.*—This process consists in the direct application of ultra-violet rays to water as it flows through a transparent pipe containing a succession of restricted orifices wherein the depth of penetration of the rays can be governed. The effective penetration in a clear and relatively colorless water may be as much as twelve inches. Ordinarily the lamps use a direct current of 220 V and 3.5 amperes. They are arranged in tandem on the principle that successive treatment of the water by the rays gives assurance of better results.

The effect of the ultra-violet ray treatment is restricted to disinfection. The process is attractive because nothing is added to the water that may impart offensive tastes and odors. The disadvantage of this method of disinfection, however, is that the lamps require rather constant attention and the safety of the system depends on the flow of water stopping automatically when a lamp gets out of order.

*Chemical Test.*—Chemical analysis of water in recent years has been concerned almost entirely with enforcing tolerance limitations set for the following elements. Acceptable water supplies contain not more than 0.1 p.p.m. of lead, 3.0 p.p.m. of copper, 15 p.p.m. of zinc, 250 p.p.m. of sulfate, 125 p.p.m. of magnesium, 250 p.p.m. of chloride, 0.3 p.p.m. of iron and manganese together, and 0.05 p.p.m. of arsenic, 0.05 p.p.m. of selenium, 0.05 p.p.m. of hexavalent chromium, 0.001 p.p.m. of phenolic compounds in terms of phenol, and 1,000 p.p.m. of total solids. Treated waters are required to contain no caustic alkalinity, no odor or taste of free chlorine, and not more than 50 p.p.m. of alkali carbonates.

Prior to about 1890 attempts were made to judge the sanitary quality of water chiefly on its chemical analysis with more or less consideration given to conditions at the source. The chemical composition of water is, however, subject to the effects of many varying factors. With the development of bacteriological methods chemical analyses have received less and less attention except for comparative purposes and the purposes referred to in the preceding paragraph.

**Distribution.**—Whether the potable water supply is obtained from a municipality or from a private supply, its distribution in the plant must be such as to assure that it retains its quality until it is used. Storage tanks are so constructed and maintained that they can be kept clean. It is generally considered to be necessary to cover tanks to protect the water from contamination by particles from the air and bird droppings. The

covers of tanks are so constructed as to permit ready access for inspection and cleaning whenever necessary.

Sometimes potable water is stored in a tank and held for the emergency of fire. The water in such tanks is changed periodically so that its potable quality may be maintained and not be a source of contamination of edible product should a fire occur in the plant. The pipelines used for distributing potable water throughout the plant are free from dead ends in which water might stagnate and become a source of pollution. Similarly, the water in sprinkler systems is changed from time to time so that should a fire occur, the water from such a system will not unduly contaminate edible products throughout the plant.

Potable water is frequently the only water available for use in cooling the compressed ammonia in refrigeration systems and where such water is purchased from municipalities it might involve an item of considerable expense. In such cases, so-called closed systems are used in which the water passes through the ammonia coils in closed pipes. Then there is no pollution of the water since it is not exposed to the air and the tempered water as it leaves the ammonia coils enters the plant's hot water system available for potable uses.

Water is commonly permitted to run over ammonia coils arranged in batteries located in towers on the roofs of meat packing plants. The water in such towers is exposed to the elements and experience has shown that pollution of the water is difficult to avoid. Such water, therefore, is not returned to the potable water system of the plant but is conveyed to a cooling tower in which the heat is removed from the water by spraying it in a circulation of air. After cooling, the water is again used over the ammonia coils.

The distribution of non-potable water in a plant is surrounded with such safeguards as are necessary to avoid its contaminating the potable water or edible product. This is done whether the non-potable water as such is brought into the plant, or as is the case with water used over ammonia coils, it becomes non-potable through its use in the plant. Large volumes are used for purely technical purposes outside of edible products departments. In addition to its use in cooling compressed ammonia it has a considerable use in the inedible products rendering department. A major part of the inedible materials which comes to the inedible rendering department consists of portions of the alimentary tract and its contents. Before this material is placed in the rendering tank its contents must be removed and the degree of effective removal has a direct bearing on the quality of the resulting tankage and inedible fats. Preparatory to rendering, this viscera is passed through large hashers and effectively shredded. This shredded mass is discharged immediately into equipment in which it is washed thoroughly of the ingested materials. A large amount of water is necessary for this washing and for this purpose non-potable water is suitable.

During the rendering of inedible materials the vapors that are exhausted from the inedible rendering tanks are condensed by subjecting them to a shower of cold water. Here again, a large amount of water is used and it may be non-potable.

These uses of non-potable water are such as to permit it being excluded entirely from edible products departments. Furthermore, the equipment in which it is used permits the effluent being confined and directed immediately to the sewer. Pipelines of non-potable water in a food processing plant, however, are potentially dangerous in that cross-connections between such lines and lines containing potable water may be made even though accidentally. Accordingly, lines containing non-potable water are painted a distinctive color and where a cross-connection between the potable and non-potable lines is made, its purpose is justified and it is of a type which will not permit contamination of the potable supply. An example of the necessity for a cross-connection would be the need for using potable water over the ammonia coils should there be a failure of the non-potable supply. A usual justification for a cross-connection is connected with fire control.

An acceptable cross-connection accomplishes a complete break between the two lines when not in use and a bleeder to eliminate any leakage from the non-potable side. An official seal is placed on the valve on each side so that any tampering with either valve can be immediately detected.

Measures are taken to avoid contamination of the potable water supply by back-siphonage into it of water from equipment to which the potable water system is connected or which it supplies. This refers to the water in water vats of all descriptions used in the processing departments throughout the plant and what is more repulsive, the water in toilet bowls. If for some reason a negative pressure develops in a water line, back siphonage occurs if the end of the water line is submerged in the water in the tank or bowl with the result that their contents will be sucked back into the water system. Devices called vacuum breakers are available for inserting in water lines whose ends are submerged in a tank or bowl of water. These devices work on the theory that should a negative pressure develop in the line, air will enter the line through the so-called vacuum breaker. The safest measure is to not have any submerged water lines. It is better that the discharge end of all water lines be some distance above the level of the water in the tank or bowl.

The responsibility of the inspection is a continuing one with reference to water supplies. The quality of the water is checked periodically to assure its safety, and its distribution in a plant is under constant surveillance to maintain it in a safe condition until use.

**Chemical Conditioning.**—Chemical conditioning of water supplies has a three-fold purpose (1) water softening, (2) avoidance of precipitation of salts to form scale in boilers and hot water systems, and (3) control corrosion in the distribution system in the plant. Hardness in water is usually referred to as carbonate (temporary) and sulphate (permanent). It is caused by calcium carbonate and magnesium carbonate held in solution by dissolved carbon dioxide and calcium sulphate and magnesium sulphate in solution. The calcium carbonate and magnesium carbonate are thrown out of solution by anything which will eliminate the dissolved carbon dioxide. The heating of water drives off the carbon dioxide and results in the precipitation of these carbonates in the boiler and hot water system.

Soft water is important as a convenience and economy since soap has very little cleansing action until it lathers and it will not lather until the

hardness salts in the water have been neutralized. The most expensive method of softening water is by the use of soap.

*Lime-Soda Softening.*—Calcium and magnesium bicarbonate are soluble in water because they are held in solution by carbonic acid and therefore in order to remove them from the water it is necessary to convert them into insoluble normal carbonates by driving out or absorbing the carbonic acid. Carbonic acid may be driven out of the water by boiling or it may be absorbed by lime. When lime is added to hard water containing calcium and magnesium salts its action is two-fold. It neutralizes or absorbs the free and half-bound carbonic acid, thus leaving the insoluble normal carbonates to settle out and precipitates the magnesium sulfate in the insoluble hydrate form. The soda ash is necessary to act upon the sulphate hardness by effecting an exchange of sodium for calcium in combination with the sulphate radical precipitating out the calcium as calcium carbonate. The soluble magnesium sulphate is acted on by both the lime and the caustic soda precipitating out the magnesium as the insoluble magnesium hydroxide.

This process accomplishes both softness in the water and the removal of salts which otherwise become deposited in the boiler and hot water system. The sludge consisting of calcium carbonate, magnesium carbonate, and magnesium hydroxide is eliminated as part of the process of treatment.

*Sodium Zeolite Softening.*—This method of softening is sometimes referred to as the base-exchange process and depends on the ability of certain insoluble substances—chiefly silicates— to exchange bases with those in the water with which they are brought in contact. When hard water is passed through a bed of sodium zeolite the calcium and magnesium in the hard water are replaced by sodium from the zeolite. This treatment can be taken to a degree of thoroughness which practically eliminates the calcium and magnesium ions. The sodium salts which remain soluble in the water have no hardening effect on the water, neither do they precipitate out in the boilers or hot water systems.

After the readily replaceable sodium in the zeolite bed has been exchanged for calcium and magnesium from the hard water, the "exhausted" zeolite is regenerated with a solution of sodium chloride by which process the calcium and magnesium of the exhausted zeolite are replaced with a fresh supply of sodium from the regenerating brine solution. The zeolite after being washed with water to free it from brine is ready to soften a fresh supply of hard water.

*Hexametaphosphate Treatment.*—This is not a water softener. Sodium hexametaphosphate is an inorganic chemical which, when added to the water, will prevent the formation of carbonate scale in the distribution system including the boilers and hot water system and at the same time it retards corrosion.

It has been found that sodium hexametaphosphate is very strongly adsorbed on the surface of many metals, metal oxides, and salts. It is probable that an adsorbed film of this chemical prevents the crystal growth as the calcium and carbonate ions begin to build up in the solution. One part per million of sodium hexametaphosphate when added to water

before chlorination or before the water has had an opportunity to absorb oxygen, for each part per million of iron in the water has been found to prevent the precipitation of dissolved iron. This prevents the development in the water of the condition known as "red water." Similarly, the chemical acts to retard corrosion in the water distribution system.

Sodium hexametaphosphate does not remove the salts which cause hardness in water, it merely acts on them in such a way as to prevent their forming a scale in the water distribution system. It is used in combination with either the lime-soda or the zeolite treatment for its action on any of the residual carbonates and for its anti-corrosion effect.

**Liquid Waste Disposal.**—Since large quantities of water are used in connection with many operations involving both edible products and inedible products in a meat packing plant, adequate liquid waste disposal facilities are imperative. There are two systems of disposal in the plant entirely independent of each other; the sanitary lines which carry the wastes from toilet rooms and dressing rooms do not connect within the plant in any way with the lines which pick up and remove other liquid wastes throughout the plant. This complete separation is necessary to avoid the kind of contamination that would result from wastes from the sanitary system backing up into edible products departments should a stoppage in the lines occur.

The lines of both systems consist of cast iron or wrought iron pipes with tight leaded or threaded joints. The size of the pipe lines is adequate to carry the peak load. Clean-out fixtures are so located throughout each system that, should a stoppage occur, it can be promptly corrected. These clean-out fixtures are so placed that they can be used without constituting a threat of contamination to edible product and the openings used for clean-out purposes are so constructed and maintained as to be absolutely leakproof when not in use.

Deep seal flowing traps are installed at each point where liquid waste enters the disposal system. The purpose of each trap is to seal off the disposal system so that odors from it cannot enter the plant. The trap is effective only when sufficient water remains in it to constitute a seal. As the water passes through the trap and down the drainpipe it tends to develop suction which would draw the water out of the trap leaving insufficient water in it to form a seal unless the suction is broken on the effluent side of the trap by venting the drainpipe to the air. Then, as the water rushes down the drainpipe away from the trap, instead of sucking the water through the trap it will draw air from the vent pipe. To be effective the vent in each case is located adjacent to the trap. The individual vent pipes are connected with a larger one which extends well above the roof so that it might discharge any odors without being offensive.

Water wasting equipment, such as meat cook vats, curing vats, cured meat soaking vats, and fat chill vats, is not connected directly with the drainage system. The discharge of liquid waste from such equipment is directed immediately into the drainage system by what is referred to as a "broken connection." This is accomplished usually by having the equipment discharge into a drained, curbed area. The purpose of this is to avoid continuity of the surfaces of the equipment handling edible product

with that of the drainage system and furthermore should there be any stoppage in the drainage line, the wastes would not back up into and contaminate the equipment and the product contained in it.

The final disposal of liquid waste as it leaves the packing plant involves two considerations. The first has to do with the reclamation of the large amount of fat from the liquid wastes before they enter the sewage system. The second involves the disposal of the entire sewage which originates in the plant and on its premises and includes that from the sanitary system.

**Catch-basin.**—This term is usually used to refer to the equipment which has for its primary purpose the salvaging of fat from liquid wastes. Incidentally, it also settles out a large portion of the solids.

The sanitary lines do not empty into the catch-basin, but combine with the effluents of the catch-basin to constitute the total sewage of the plant.

The type of catch-basin depends on the size of the plant and the character of the waste. It should have a capacity for about a ten minute maximum flow and be designed for a velocity of about 4 to 5 feet per minute. The catch-basin is designed to retain floating material which consists principally of the fat to be salvaged and to provide for continuous removal of the material which has settled to the bottom. The catch-basin is located in the open air outside the plant and should be uncovered. Experience has shown this to be practicable even in cold climates.

The floating material is skimmed off regularly into water-tight containers in which it is taken to the inedible rendering department. The area around the catch-basin is paved and drained; a hose outlet facilitates ready cleanup.

The catch-basin is equipped with a device which moves the materials that have settled to the bottom to one end of the tank from which they are removed periodically during the day. This way the settlings are removed before they decompose and do not cause an objectionable condition.

The catch-basin is completely emptied and cleaned out thoroughly each day following the plant operation.

**Sewage.**—The sewage from meat packing plants presents a disposal problem because of the large flow, seasonal variations in volume of operations, high peak production, strength of wastes, high temperature of the wastes and their disagreeable odor. Because of this, many meat packing plants are prohibited from emptying their sewage directly into the municipal sewage system or into rivers or streams.

Meat packing plants therefore commonly provide some facilities for the treatment of sewage before the liquid wastes of the plant are permitted to enter the local sewage system, rivers, or streams. As this equipment relates to the environmental sanitation of the plant, it has a bearing on meat hygiene. The location of facilities and the disposal of sludge are the principal factors in this connection.

The sewage treatment facilities are located some distance from the plant and are so constructed and maintained as not to create a nuisance. They generally consist of a series of settling basins and tanks for chemical treatment of liquid waste, the object being to have the liquids clear as they are finally discharged and with a biochemical oxygen demand not higher than the requirements of the local sanitary officials.

The procedures may be divided into three main classes: mechanical treatment, chemical treatment, and activated sludge process. Generally, a combination of these procedures is used. The operation entails the separation of the solids from the liquid followed by treatment of the two parts separately.

*Mechanical Method.*—This method removes the solids from the sewage with the use of screens, filters, sedimentation basins, trickling filters, and grit chambers. Grit chambers are shallow rectangular tanks in which the velocity of flow is checked so that the grit will settle out carrying with it some of the organic material.

*Chemical Treatment.*—This treatment precipitates the solids by coagulation. The coagulated materials are removed by sedimentation or filteration. Ferric sulfate or chloride or aluminum sulfate with lime are commonly used as coagulants.

*Activitated Sludge Process.*—This is the most effective method for removing both suspended and dissolved substances from sewage. The raw sewage is digested by microorganisms. One method employs aerobic microorganisms, while in another the sludge is activated by seeding it with anaerobic microorganisms.

The disposal of the solids removed from the sewage in connection with the use of any of these processes depends on local conditions. In some cases they are buried or used as filling; in other cases they are sold as fertilizer.

Before the liquid resulting from the treated sewage is discharged into a stream it is usually chlorinated as its final treatment.

The removal and disposal of sludge is accomplished without creating objectionable odors or a fly-breeding nuisance. This means that it must be properly digested and promptly dried.

**Outside Premises.**—Sanitation in a meat packing plant can be influenced by the condition of the surrounding premises. The meat as it is prepared and handled in the plant is exposed to the outside elements through open windows and from areaways and loading docks. Any air-borne odor or contamination which may result from an unsatisfactory condition of the outside premises would interfere with the sanitary handling of the product in the plant. In this connection meat packing plants are not located adjacent to industries which give rise to objectionable odors such as chemical manufacture, for example.

All roadways servicing the plant are paved with a hard surface that will not produce dust as traffic passes over them.

Railroad sidings servicing the plant are paved where the meat is loaded in or unloaded from railroad cars. In addition to being paved so that the motion of air will not create an atmosphere of dust at the loading areas, the railroad sidings are also drained so that they may be washed down and cleaned thoroughly at regular intervals.

**Loading Docks and Areas.**—Since the entire production of meat and meat food products of the meat packing plant is handled through the loading docks and areas, these places are so constructed and equipped as to maintain clean conditions under which edible product is handled. The docks are covered so that the product is protected in all kinds of weather. The surface of the docks and loading areas is paved with concrete or other

impervious material with drains so located as to facilitate regular cleanup. Conveniently located hose outlets are provided for this purpose. The overhead rails used for conveying carcass meat are at least 7 feet high so that the meat will hang sufficiently high above the floor to avoid contamination. Lavatories are provided so that truck drivers and loaders may cleanse their hands when necessary before handling unpackaged meats.

Docks for handling inedible materials are completely separated from docks where edible product is handled. The inedible product dock services the inedible product department exclusively. This dock and its approaches are also paved, drained and supplied with clean-up facilities.

**Livestock Pens.**—Unpaved and improperly drained livestock pens can create a real nuisance on the premises. Furthermore, to avoid holding animals under unsatisfactory conditions the pens are of sufficient number and size to accommodate the peak load. All of the pens and runways from the livestock unloading platform to the slaughtering department are paved with some such impervious surface as concrete. These areas are also curbed and pitched to drains so that after the solid debris has been picked up and carted away, the entire area can be washed down thoroughly. The drains are usually located immediately under the water troughs in each pen so that splash from the trough will flow immediately into the drain and not create a nuisance as it would if it were allowed to flow across the floor of the pen. Sufficient hose outlets are provided throughout the pen area for convenience in washing down the floor of each pen at the end of each day's operations. It is a common practice during the summertime to spray with water truckloads of livestock upon their arrival at the plant before unloading. In such cases a paved and drained area is provided where the spraying is done so that the waste water will be confined and conducted directly to a drain.

**Rodent Control.**—This is a continuing problem in a meat packing plant. The location of the plant and the kind of products handled on the premises predisposes infestation with rats and mice. The filthy and dangerous character of rodent contamination of meats intended for human food makes it imperative that rats and mice be eliminated completely from inside the meat packing plant.

There are three kinds of rats: the brown rat (Rattus norvegicus), the black or ship rat (R. rattus rattus), and the Alexandrian or roof rat (R. r. alexandrinus). The last two are subspecies of the R. rattus which occur only in comparatively limited areas, chiefly at seaports in the Gulf States. The brown rat, or house rat, is the one most commonly known and it has no subspecies.

Brown rats may be black and have other variations in color and they also vary in size. These variations give the impression that there are a number of entirely distinct species occurring during an infestation of brown rats. This rat is known by various names depending upon the locality or environment in which it is found and on the size and color of the rats making up a local infestation. They are sometimes called barn, wharf, sewer, gray, and Norway rat.

The brown rat first made its appearance in the United States around 1775. They were first introduced at the various seaports where the rats

gained foothold in the United States and gradually spread inland until now they infest every State in the Union.

As the house rat is entirely dependent upon food and shelter provided by man, its spread into new territory followed the migration of people. Its spread into high mountainous areas and extremely dry areas progressed comparatively slowly. Though entrenched in some of the larger towns in Colorado and New Mexico by 1890, it did not reach Wyoming until about 1919 and Montana until 1923.

The brown rat thrives best in the temperate zone where it has almost completely replaced the black rat, but in the Southern States, particularly in Florida and in the southern parts of the States bordering on the Gulf of Mexico the black rat has held its own and predominates in some places.

The brown rat may be distinguished from the black rat by its relatively large size, more robust build, shorter, thicker ears, and shorter tail which, when bent forward, does not reach the tip of its nose, whereas that of the black rat extends considerably beyond. The rather soft fur of the brown rat is usually a greyish brown, fading to a dirty silver grey or pale yellowish white on the belly. Individuals may vary in color from an almost pure grey to reddish-brown or nearly black. Partial albinos are not rare.

The average adult weight of the brown rat is about $\frac{3}{4}$ of a pound. Individuals weighing 1 pound may be considered unusually large. The average length of the adult is 16 to 18 inches including the tail which is 7 to 7½ inches long. The number of young in the litter of the brown rat varies from 6 to 22, the average being 9, or, in the North Temperate Zone, probably 10. The number of litters produced in a year is reported to vary from 3 to 12. The young are blind and hairless at birth, but grow rapidly and breed when only three or four months old. The life span of a rat is probably between three and five years. Abundant evidence demonstrates that the house rat breeds every month in the year, and there is one record of 7 litters in 7 months from a single pair. The number of litters under average conditions, however, probably varies from 3 to 6 a year. The period of gestation is considered to be twenty-one to twenty-five days. The nests, built of scraps of paper, rags, grasses, or any other soft material, are placed in underground burrows or under floors, wood piles, or any other structures or accumulations that afford shelter near an available food supply.

The brown rat is naturally a burrowing rodent. At times, it may be found in open fields and particularly along ditch banks and water fronts, by far the greater number live in burrows under or adjacent to buildings or within man-made structures. Although not physically adapted for extensive burrowing, the rat is communistic in its mode of living, and cooperation in extending underground runways sometimes results in an extensive maze of tunnels interspersed with nest chambers, though the burrows rarely extend downward more than 18 inches. As many as 281 rats have been taken from a single system of burrows under one small chicken house.

The brown rat is an expert climber, although in this respect it is not equal to the black rat, which lives largely in the upper parts of buildings and in trees. Although frequently found in the upper stories of buildings, the

brown rat goes there for the most part only on foraging expeditions and retires during the day to the lower floors and basements or to its burrows under the floors. It is also an excellent swimmer and does not hesitate to take to the water in cases of necessity. It is extremely quick but is not able to run so fast as some other rodents of the same size.

Because of the close association of rats with man and domestic animals and because rats are scavengers living on both filth and edible foods, frequenting alternately sewers and places where food is prepared and handled, privies and larders, running from places where disease organisms abound to places where otherwise sanitary conditions would prevail, carrying the disease organisms on their feet and in their fur and stomachs, they play an extremely important role in the spread and dissemination of disease. Not only do they serve as mechanical carriers of disease but a number of their own diseases are transmissible to man. The rat is also subject to certain human diseases which it acquires and disseminates. Rat-borne diseases are bubonic plague, typhus fever, spirochetal jaundice, rat-bite fever, tularemia, rabies, trichinosis, and food poisoning.

Unless the places in which rats are living are destroyed and potential habitations broken up, control methods are rarely successful. Rats can always find enough food available to sustain life. As long as a place to hide and rear young is available they will continue to survive. Studies have shown that after a poisoning campaign the rat population will regain its former numbers within about nine months or less if no further control measures are undertaken.

Food and shelter are the two most important factors in a rat's existence. It hunts for a food supply and for a convenient harborage nearby. When these two attractions are eliminated the premises lose their appeal to rats. If they are ignored new rats will appear as fast as the old ones are killed off. A successful control program incorporates four major phases: elimination of rat harborages, elimination of food supply for rats, rat-proofing of buildings, and destruction of rats. A program incorporating these controls must be continuing to be successful.

The brown rat commonly lives underground, beneath stored materials, between double walls, and in other similar enclosed spaces. Until such harborages have been eliminated or made unavailable, other control measures will give only temporary relief. All burrows are broken up. Stored materials are placed on racks 12 to 18 inches off the ground. Piles of rubbish and discarded material are not allowed to accumulate. Spaces between double walls are made unavailable by rat-proofing.

Cement, hardware cloth of $\frac{1}{4}$ inch or $\frac{1}{2}$ inch mesh, and sheet metal of 26 gauge or heavier are all good rat-proofing materials. The exterior of buildings is examined for any openings larger than $\frac{1}{2}$ inch which must be closed if rats are to be kept out. Wooden sills and doors at ground level are sheathed in sheet metal to prevent their being gnawed. Windows less than 4 feet off the ground where brown rats are present and at any height from the ground where the climbing rats are prevalent are screened with hardware cloth. Foundation walls, particularly where utility lines enter the building are pointed up with cement.

Where rats burrow beneath a foundation to enter a building, a curtain

wall in the shape of an "L", 2 feet deep and 1 foot across the footing is provided. Rats will drill down 3 or even 4 feet but rarely will they cut around the footing. In the case of open buildings such as barns and sheds, it is largely a matter of making certain that no harbor is present so that if a rat does run through the building it will have no place to hide.

Dumps, if not properly maintained provide an excellent rat harborage. Rats can be eliminated from dumps by using a bulldozer to grade and tamp down the material as it is placed on the dumps. Old dumps can be made rat-proof by first smoothing off the surface with a bulldozer and then covering the dump with 3 feet of clean dirt.

Outside premises of the packing plant are kept free of all debris. Refuse is hauled away daily. Unused or obsolete equipment is not permitted to accumulate on the premises to serve as a harbor for rodents.

With the destruction of places in which rats can live and their potential habitations broken up, control measures aimed at destroying rats with the use of bait and traps are successful. The most efficient means of effecting wholesale destruction of rats is the use of poisons. Poisons that are deadly for one warm-blooded animal, however, are also more or less poisonous to others. For use in a packing plant the poisons best suited are those which can be used by the average person without difficulty and which are the least toxic for man. The ones best suited for use in rodent bait are red squill, and ANTU. For use as a fumigant, hydrocyanic acid gas is the most effective.

**Baits.**—Baits are made sufficiently solid and hard so that they cannot be broken up and scattered about, or are made soft and placed in a dish or other receptacle protected by a box or cage in which openings are sufficiently large for the rats to enter but not large enough to permit removal of the dish. Baits are not placed in departments where edible products are handled or prepared until after operations have been ended for the day. Strict account is kept of the location and the number of baits set out. All uneaten bait is gathered up and destroyed before operations are begun the next day. Because of the way meat is handled and stored in dry-salt cellars, baits are not placed in these departments.

Rats are omnivorous; that is, they will eat almost any kind of food. Like human beings, some individual rats have definite preferences which must be catered to, but, generally speaking, bait materials consist of cereals, meats, fish, cheese, fruits, and vegetables. Often a change in the kind of food offered will produce greater success. If the rats have been eating poultry feed, baits with a meat or a fish base may yield the best results. On the other hand, occasionally rats will refuse to touch a food they are not accustomed to eating. More important than the materials used, however, is proper preparation of the baits. Too much poison in the mixture is just as faulty as too little, for acceptance will be cut down. If the poison is not thoroughly mixed with the bait material, some parts of the bait will have too strong a concentration, while others will have too weak a one to produce results.

Bait material in small lots, up to a pound or two, can be mixed readily with a large spoon or paddle in a mixing bowl, pail, or similar container. Articles used in mixing poisons are used for that purpose only and kept

separate from all other utensils. They are labeled "POISON." Only enough bait for use on the same day is mixed at one time. Baits are most acceptable when fresh.

Of greater importance than the kind of bait used, is the proper placement of the material. Rats seek shelter and protection in their movements as far as possible. Baits placed in rat travelways and harborages are far more likely to be found and sampled than those exposed in the open. Baits should be placed under cover whenever possible. An old board or a box can be leaned against a wall to cover a runway. A permanent bait station for exposing the poisoned baits can be made from an inverted box with two 2 by 3 inch holes cut in each end. This has the added attraction of providing harborage when trash piles or other rat shelters are cleaned up. In any event, baits should be placed where rats are and where they are moving, and not merely scattered anywhere at the convenience of the person distributing them.

Of equal importance is the distribution of enough bait. It is better to put out more than is strictly necessary. Baits should be made into small balls about the size of a walnut or a marble. Care to prevent the odor of the hands from remaining about the baits or the station need not be taken, as rats are familiar with human scent. Sometimes it may be desirable to wrap the baits in a small piece of tissue or waxed paper. This can be done simply but cutting the paper into 4-inch squares, then folding one square over each bait and twisting the ends. This will keep some baits fresh over a longer period. It also provides a convenient means of handling dry bait mixtures, and affords greater protection to other animals. The main objection to this method is that the rats will often carry the torpedoes, as they are called, back to their nests but will not eat them.

*Red Squill.*—Red squill is obtained from the bulb of a lily-like plant that grows in the Mediterranean region. It has the peculiar advantage over other poisons of containing an emetic agent that causes vomiting in most animals other than rats and thereby the poison is eliminated. Furthermore, it has a disagreeable taste, so that many animals will not touch it. Nevertheless, it is a poison and should be treated as such.

Red squill, as imported, lacks uniform toxicity and often may prove to be an unreliable rat poison unless it has been brought up to uniform strength by an extraction process. Purchasers should insist upon obtaining red squill that has a guaranteed minimum toxicity not to exceed 500 mg (500 milligrams of the toxic element to a kilogram of body weight of the rat). The most satisfactory results are obtained when the poison is mixed with the bait material in the proportion of 1 to 9; that is, the resulting mixture should contain 10 per cent red squill. When dry cereal is used as the base, the red squill should be added to the dry ingredients and the mixture stirred thoroughly before water is added. When meat or fish is used, a thin paste of red squill and water is prepared, care being taken to avoid lumping, and this is then blended with the bait material.

*ANTU.*—ANTU is the abbreviated name for the chemical alphanaphthylthiourea, which is highly toxic to the common brown rat, but much less so to the black and other forms of climbing rats. For this reason ANTU is not recommended for general use in areas in which the climbing rats

predominate, as in the Southern States. ANTU is a greyish-white powder, insoluble in water, chemically stable, and non-irritating to the skin of human beings. It kills rats by causing an accumulation of body fluids within the chest cavity, literally drowning the animals.

Dogs and other pets, pigs, and day-old chickens are easily killed by ANTU. Although many other domestic animals are more resistant to this poison, all precautions should be taken to prevent children, pets, domestic animals, or foodstuffs from coming in contact with it.

Most effective results are obtained when ANTU is used in food baits in a concentration of 1½ per cent. It is essential that a complete coverage be made when baiting with this poison. Rats receiving less than a lethal dose build up a tolerance as well as a strong dislike for the material. Operations with ANTU should not be conducted at intervals of less than four to six weeks. Hence, in a permanent control program in which ANTU is used, it should be alternated with some other effective rodenticide.

Poisons which are not considered suitable for use under conditions prevailing in meat packing plants are phosphorous compounds, sodium fluoroacetate (compound 1080), and thallium sulphate which are highly toxic substances.

**Fumigation.**—Control of rats by means of poisonous gases includes the fumigation of buildings and structures, and the gassing of burrows. The fumigation of buildings requires considerable preparation and special techniques. It should be attempted only by persons trained for such work. In many areas the use of poisonous gases is controlled by local regulations.

The gassing of rat burrows out-of-doors is an excellent means of control. Many rats are destroyed underground, so there is no problem of the disposal of the carcasses. Gas has the advantage over poisons of destroying the flea and mite parasites as well, a factor of considerable importance in controlling the spread of some diseases.

The gas most commonly used in rat control is calcium cyanide, in a dust or finely powdered form. It is easily expelled by means of a foot, or stirrup pump, designed particularly for the purpose. The nozzle of the hose is inserted in the burrow, the rest of the opening sealed with earth, and 5 or 6 strokes of the pump handle provide the initial distribution. If gas is seen escaping from other holes, these, too, should be sealed, or the rats will escape. The valve on the bottom of the pump is then switched over to "air," and the gas is forced through the entire burrow system. Burrows that have been gassed should always be broken up with a pick or a shovel the next day and the earth tamped down tightly. The remaining rats will reopen the burrows, and these can thus be detected and retreated until all activity ceases. Extreme care must be taken in handling all cyanides since they are very toxic for man.

Carbon monoxide, introduced into rat burrows by means of a hose attached to the exhaust of a gasoline motor, has also been used with a fair degree of success. About five minutes running time to a burrow will usually suffice. As carbon monoxide is not so swift acting as calcium cyanide, it requires more gas and longer time to take effect.

Carbon dioxide, in the form of dry ice, has been found useful in fumigating refrigerated warehouses where low temperatures must be maintained to

prevent food spoilage. The ice is crushed and distributed through the room. An electric fan will speed up the dispersal of the gas. Carbon dioxide is used in about 15 per cent concentration, or 30 pounds to 1,000 cubic feet of space, for twenty-four hour exposure. It has the advantage of being much safer to handle than the highly toxic forms of gas.

Other types of poisonous gases are not recommended for general use in rat control.

**Rat Viruses.**—So-called rat viruses are not used in packing plants inasmuch as the organisms used belong to the same group as those that produce food poisoning and their use cannot be subjected to adequate control. The so-called viruses are supposedly capable of starting an epidemic among

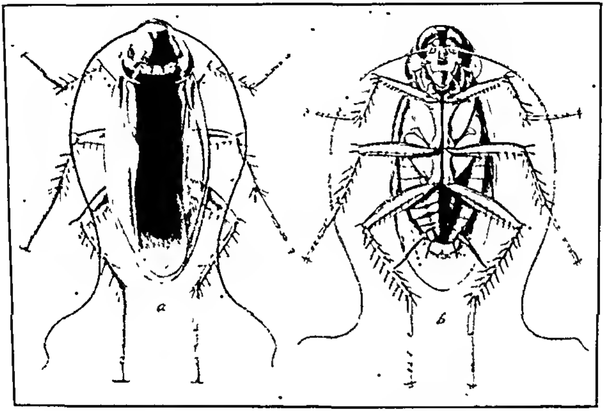

FIG. 59.—The American cockroach: *a*, View from above; *b*, from beneath.

the rat population. This method of destroying rats has rarely proved effective. Rats killed by eating the infected food must be eaten by other rats in order for the disease to be passed on. The sale of rat viruses is prohibited in some localities.

**The House Mouse.**—House mice have a long breeding season. The gestation period is twenty-one to twenty-four days, and the average number of young, born blind, hairless, pink, and helpless, is 5. They become independent of the mother in about three weeks and are sexually mature in two to three months. The mother breeds three to six weeks after a litter is born and ordinarily has from 5 to 8 litters a year.

The usual length of life is fifteen to eighteen months, but individuals may live as long as six years. Their breeding potentialities considered, it is easy to understand why, under favorable conditions of weather and food, there have been great plagues of mice. The last great mouse plague

in the United States was at Buena Vista Lake, California, in the fall and winter of 1926–27.

This little rodent has keen senses, with the exception of that of sight. It is good-natured and curious; climbs, jumps, and swims well, although it rarely goes into water. House mice readily adapt their ways of living to changing environment. They generally follow regular lines of travel that they have established.

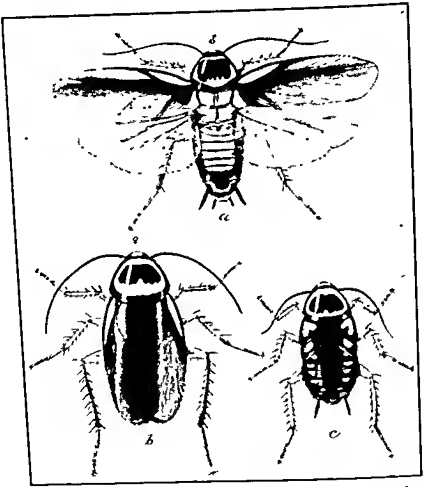

Fig. 60.—The Australian cockroach: *a*, Male with wings spread; *b*, female; *c*, nymph

Mice are kept under control in the meat packing plant by eliminating all harbors and by trapping.

**Insect Control.**—Insect infestation and the preparation and handling of edible products are not compatible. Insects breed and feed on filth as well as on food prepared for human consumption. They contaminate foods with which they come in contact both with their excrement and foul material adhering to their bodies and appendages. Food may also be contaminated with the bodies of dead insects.

Insecticides are so used that they cannot in themselves contaminate edible products and the use of those having a residual action must be such

as to avoid dead insects falling into edible product as it is being processed. There are two classes of insecticides in this connection; the one has a so-called "knockdown" action, the other has a continuing residual delayed action. Those with the residual action are not used in departments where edible products are prepared. In such departments the insecticide with an immediate or "knockdown" action is employed during the periods when meat processing operations are not in progress. This permits the insecticide and dead insects to be completely removed from the department by a thorough clean-up prior to the starting of the meat processing operations.

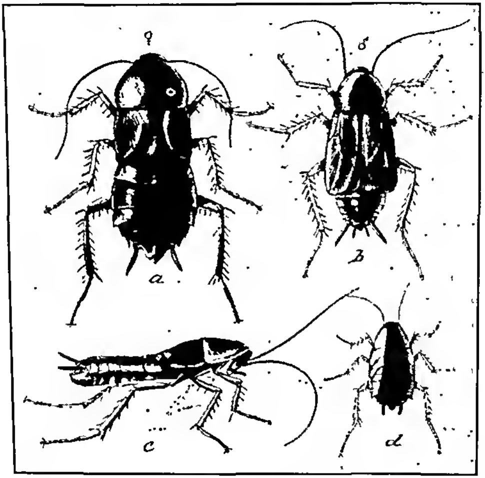


FIG. 61.—The oriental cockroach: *a*, Female; *b*, male; *c*, side view of female; *d*, half-grown specimen.

The insecticides with delayed or residual action are excellent for use in departments where there is no exposed meat such as the outside premises, the inedible products departments, pens, loading docks, dry storage rooms, toilet rooms, dressing rooms, and offices. In any case, the use of insecticides must be accompanied with the elimination of places where the insects may breed and hide.

**Cockroaches.**—Five kinds of cockroaches are encountered in America. The American cockroach (*Periplaneta americana L.*) is the largest; it is from 1½ to 2 inches long when full grown. It is light-brown. All of the adults have long, powerful, reddish-brown wings.

The Australian cockroach (*Periplaneta australasiæ F.*) resembles very closely the American cockroach but is seldom more than 1¼ inches long

and is easily identified by a bright-yellow heavy line on the outer edge of the basal half of the wing.

The oriental cockroach (*Blatta orientalis L.*) or "black beetle" is entirely black or dark brownish black attaining a length of about $1\frac{1}{4}$ inches. Of all the cockroaches it is the most sluggish in its movements and thrives best in very damp places. The female is almost wingless and cannot fly.

The German cockroach (*Blattella germonia L.*) "croton bug" or "water bug" is one of the smallest roaches, measuring up to $\frac{5}{8}$ of an inch long. It is light-brown and is marked on the back between the head and wings with two dark parallel stripes. The wings are of uniform light-brown color.

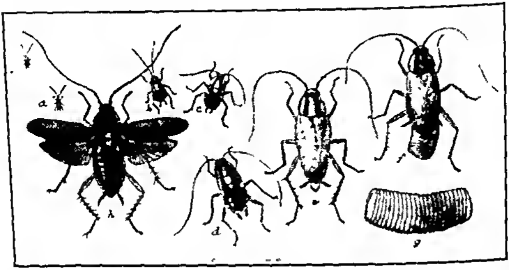

Fig. 62.—The German cockroach: *a*, First stage; *b*, second stage; *c*, third stage; *d*, fourth stage; *e*, adult; *f*, female with eggs; *g*, egg case (enlarged), *h*, adult with wings spread.

The tropical cockroach (*Supello supellecticium Serv.*) infests the cities of the Gulf Coast region. It is slightly smaller than the German cockroach, many females being only $\frac{3}{8}$ of an inch long whereas the male is about $\frac{1}{2}$ inch long. The females have bodies much broader than the males and wings that are reddish-brown; the wings of the male are much lighter. Both sexes are distinguished from the German cockroach by two cross-bands of bright yellow, one at the base of the wings and the other about $\frac{1}{16}$ of an inch further back.

The cockroach lays its eggs in leathery capsules which the female carries for several days partially extruding from her body. She often glues these capsules finally to some object, but sometimes merely drops them unattached about the places she frequents. The capsules of the croton bug and of the tropical cockroach which are hardly $\frac{1}{4}$ of an inch long often contain from 25 to 30 eggs. Roaches of all species are very small when hatched but so resemble the broad and flattened shape of the parent that they can be identified easily as cockroaches. It is only after they reach maturity that the wings develop. The cockroach develops rather slowly and is capable of subsisting under unfavorable food conditions for long

periods. As a result, roaches in all stages of growth are usually present at the same time. The German roach may pass through two or three generations a year but most roaches require about one year to become mature.

Cockroaches are nocturnal in habit. They hide during the day in shelters or darkened places where they congregate in large masses. They forage at night when all is still and dark. If disturbed while foraging, they run rapidly for shelter. Knowledge of where they conceal themselves is usually the key to their control.

Cockroach elimination is not difficult if the sources of infestation can be controlled. This contemplates elimination of shelter for the cockroach within the meat packing plant, and in mild climates control measures are extended to the surrounding premises. Roaches may develop outdoors in mild climates and from there crawl into or fly into a meat packing plant.

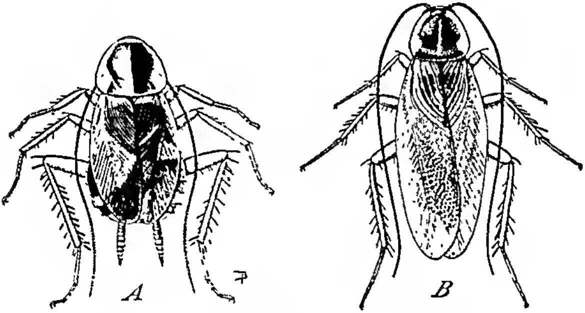


Fig. 63.—A tropical cockroach: *a*, Female; *b*, male.

The departments in which exposed meats are processed and handled are examined thoroughly for cracks and crevices which might shelter cockroaches. All such places are eliminated. Rooms, such as toilet and dressing rooms and rooms used for dry storage are kept clean and free of debris which might harbor the cockroach and then these rooms are treated regularly with insecticides. The insecticides most commonly used for the effective control of cockroaches are sodium fluoride, DDT (dichlorodiphenyltrichloroethane), and chlordane. DDT and chlordane are not used in departments where exposed meat is processed and handled. These insecticides have a residual action which would carry over and be effective during the period when meats are being prepared and handled creating the danger of dead insects falling into and contaminating the edible product. Sodium fluoride is used in edible products departments after the processing operations are completed and all exposed meats are removed from the room. A thorough cleanup completely removes the sodium fluoride and dead roaches before the processing of meats is resumed.

DDT and chlordane are used in dry storage rooms, toilet rooms, and dressing rooms where their continuing action produces effective control. Also, these insecticides are effective when used to treat outside premises and inedible products departments of the meat packing plant.

**Flies.**—*Housefly* (*Musca domestica L.*).—This fly lays its white eggs in masses on the breeding media. It seems to have certain preferences, but will breed freely on any excrement and decomposed material. The eggs hatch in from ten to twenty-four hours and the larvæ or maggots feed on the material on which the eggs are laid and reach full size (about $\frac{3}{8}$ of an inch long) in from four days to several weeks depending on temperature. When full grown the larvæ move away from the moist parts of the breeding material to comparatively dry surroundings. Here they pupate. The

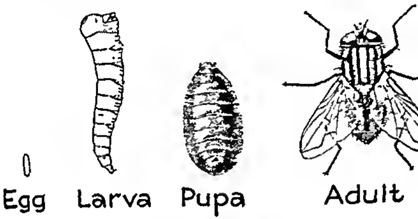


Fig. 64.—House fly.

pupæ are yellowish to dark-brown, depending on their age, and are barrel-shaped. The pupal stage lasts from three to six days in warm weather and may last many weeks in cold weather. When transformation is complete, the adult fly pushes open the end of the pupal case, works its way to the surface and expands its wings until fully developed and dry. The female mates and is ready to lay eggs in from two and one half to twenty days after emergence. From 2 to 21 egg masses, each containing about 130 eggs may be deposited by 1 female during a normal lifetime of from two to twelve weeks. The adult fly takes food for the most part in liquid form, but flies can ingest minute objects and are known to ingest eggs of parasitic worms.

*Blow Fly.*—Several species of the larger, green and bluish colored flies with metallic sheen and also some grey-colored blow flies are encountered on the premises of meat packing plants. Blow flies breed mainly in carrion although some will breed in excrement, especially of man and hogs. They will breed in garbage, particularly if it contains meat or meat wastes. They also deposit eggs ("blow") on either raw or cooked meat.

The eggs of the blow fly hatch in from six to forty-eight hours, the growing larvæ feed on the breeding media for from three to nine days after which the full-grown larvæ leave the food and bury themselves in the loose earth.

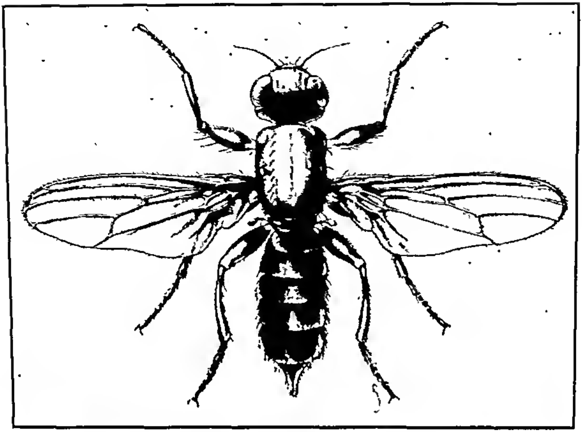

FIG. 65.—Ham skipper—adult fly.

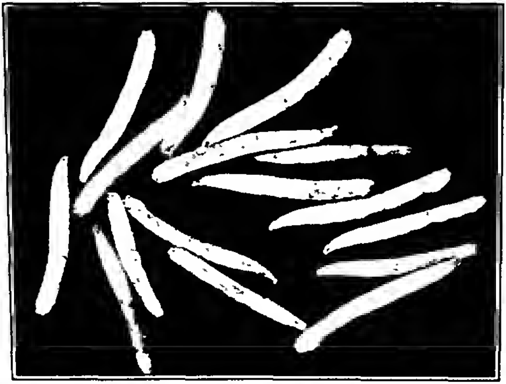

FIG. 66.—Ham skipper—well grown larvæ.

The pupal period lasts from two to seven days under favorable conditions after which pupation takes place. The pupal period varies considerably according to temperature. The life history of the blow fly requires from sixteen to thirty-five days under favorable conditions. The life of the adult averages about thirty-five days.

*Ham Skipper (Piophila casei L.).*—The adult is a shiny black fly about $\frac{3}{16}$ of an inch long. It is characterized by the position of its wings which extend laterally at right angles to its body. It gets its name from a characteristic of its larvæ which infests hams and has the ability to bring both ends of its body together and to suddenly hop or jump a distance of 3 or 4 inches. The adult lives on an average of about three or four days during warm weather and deposits about 140 eggs. The tiny, white eggs are

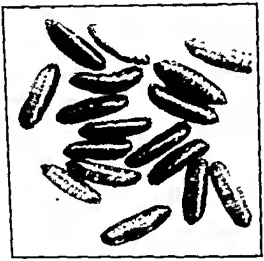

FIG. 67.—Ham skipper—puparia.

scattered over the surfaces of exposed meats, especially cured and smoked pork, but may also infest cheese. They hatch in about twenty-four hours at 80° to 90° F. The larvæ or maggots are white and may become full grown in five days when they are about $\frac{3}{8}$ of an inch long. Another five days may be passed as a pupa in the puparium which is about $\frac{5}{16}$ of an inch long. The life cycle from the laying of the egg to the emergence of the adult may require only fourteen days, and two generations a month in warm weather are common. Reproduction proceeds actively between 56° and 120°F.

**Beetles.**—*Ham Beetle (Necrobia rufipes De Geer).*—This is a small, shiny, bluish-green beetle with black eyes and with the legs and the first five segments of the antennæ of a reddish-yellow color. It is not more than $\frac{1}{4}$ of an inch long. The adult beetle may live fourteen months during which time individuals have laid as many as 2,100 eggs. These eggs are scattered over the surfaces of meat. In warm weather, incubation of eggs may require only four days The larvæ is elongated about $\frac{3}{8}$ of an inch when well grown which takes about seventeen days. When about to be transformed

to the pupal stage, the larva constructs a white paper cocoon from droplets of a frothy material emitted from its mouth. About thirteen days after constructing the cocoon, the adult emerges. The life cycle from the laying of the egg to the emergence of the adult may be completed in as few as thirty-four days in warm weather.

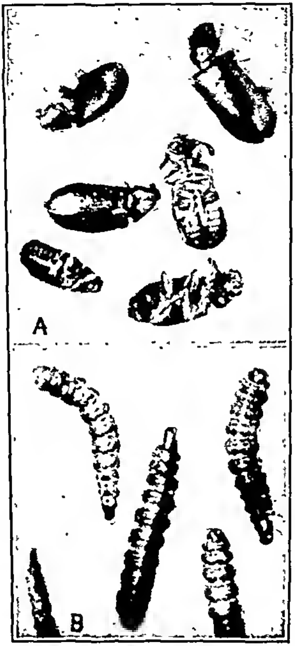


Fig. 68.—Ham beetle: A, Adults; B, larvæ.

*Larder beetle* (*Dermestes lardarius L.*).—These are robust, brownish-black beetles distinguished by a broad, yellowish-grey band across the basal portion of their wing covers. The adult is a strong flier during warm weather or in a heated room. Individuals have lived from three to seven months and they lay several hundred eggs. The eggs are scattered on cured meat and particularly dried meat products. The incubation period for the eggs is from three to eight days during warm weather. The larvæ are ½ inch long when well grown, grownish in general color, with a lighter-

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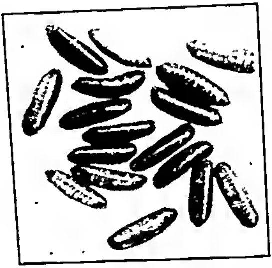

Fig. 67.—Ham skipper—puparia.

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brown stripe running lengthwise along the center of the back. They are white underneath and have two rather short but distinct spines on the rear near the end of the body. There are also conspicuous long, blackish spines on the body. It requires from three to four months to pass through the larval stage. It is seldom that a generation can mature in less than three months under favorable summer weather.

**Ham Mites.** (*Tryoglyphidae*).—These 8-legged meat infesting mites also attack cheese and are tiny, soft-bodied creatures, almost colorless, which appear on the product as whitish spots. They multiply fast and molt frequently.

**Control.**—The prevention of insect breeding is the most important consideration in insect control. The outside premises of the packing plant are kept free from accumulations of all vegetable and animal material which may decompose and serve as breeding media. Sewage disposal systems are watched closely to detect fly breeding places. Sludge, especially if not properly treated and dried, may provide excellent breeding material. Heavy scum if permitted to accumulate on settling tanks and sludge drying beds provides ideal breeding conditions.

Daily cleanup throughout the packing plant eliminates insect breeding places. All openings in buildings are protected with well-fitted screens. The screens are at least 16 meshes to the inch so as to exclude all sizes of insect pests. Ceiling fans installed over entryways aid in keeping out insects.

The use of flytraps is an important adjunct in the ordinary procedure in the prevention of fly breeding. Huge numbers of house flies and blow flies may be caught in properly constructed and properly baited traps set at strategic locations. The traps are set where flies naturally congregate. The conical-type trap as shown in figure 145 has been found to be the most effective and easily handled. The trap is from 12 to 18 inches in diameter, the sides and top built of screen with a cone reaching nearly to the top. The bait is placed beneath the trap in a broad shallow pan about 4 inches less in diameter than the base of the cone and 1 inch deep. The bait pans are kept well-filled and are washed out regularly. Flies are not permitted to pile up in the trap since this reduces its efficiency.

Despite every effort to prevent insect breeding, some insects will be produced. In many cases, screening and trapping do not prove to be adequate control measures in themselves and it is necessary that they be implemented with the use of insecticides.

Pests become resistant to pesticides. Resistance seems to occur after several generations of a pest have been treated with a chemical. Some of the strongest individuals are not killed but live to produce young. In the next generation and each succeeding generation, the weaker individuals die while the tougher ones survive such exposures to pesticides. In time and with continued exposure practically all of the pests are able to withstand almost any amount of the chemical. This selection usually takes many generations before the first widely used pesticide fails.

Such resistance is passed on from one generation to the next. This is regarded as being something different than the development of immunity against disease. Resistant pests pass on their strength to their offspring.

Without exposure to any of the chlorinated hydrocarbons, resistance will be lost in a few generations. However, upon exposure, resistance will return quickly again.

**Packinghouse Employees.**—At many points in the various stages of handling and processing incident to preparing meats and their products for human food, employees of the meat packing plant come in close and frequently in direct contact with food articles. Packinghouse employees are an important element in the environmental sanitary control in the plant.

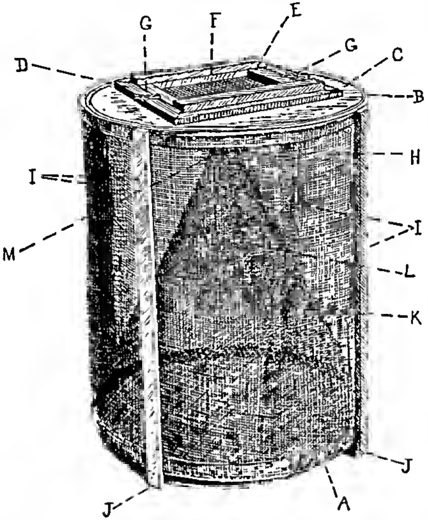


FIG. 69.—Conical hoop flytrap, side view: *A*, Hoops forming frame at bottom; *B*, hoops forming frame at top; *C*, top of trap made of barrel head; *D*, strips around door; *E*, doorframe; *F*, screen on door; *G*, buttons holding door; *H*, screen on outside of trap; *I*, strips on side of trap between hoops; *J*, tips of these strips projecting to form legs; *K*, cone; *L*, united edges of screen forming cone; *M*, aperturo at apex of cone.

A program of employee education and training in the importance of personal cleanliness and the maintenance of clean working conditions is part of breaking in a new employee for work in a packing plant. He is also given the facilities to aid him in his personal cleanliness.

Most local jurisdictions have laws that require certification as to health of people who work in food handling plants. These laws usually require periodic health examinations. Complete reliance is not placed on such health examinations in packing plants in which inspectors are located.

The inspector is on the alert for those cases where an employee shows some indication that he or she may be affected with a contagious disease in the communicable stage. When an employee is suspected of being affected with such a condition, he is required to obtain a physical examination and certification from the examining physician that he is in fit condition to handle food before being permitted to continue in the employment.

The inspector is constantly on the alert for conditions involving the hands or arms of an employee that would be a probable source of contamination for meat which the employee handles. Open sores are particularly dangerous because frequently the bacterial infection involves the same organism that produces food poisoning. Open sores on any exposed part of the body are a probable source of contamination.

Nail polish is another offender. The working conditions tend to loosen nail polish and particles flaking off contaminate the food product. Both sexes are required to wear a headdress that is adequate to prevent falling hair from contaminating the food.

Only washable outer garments are worn by packinghouse employees and these are changed and laundered frequently. The employee's outer garments are laundered for the employee either by facilities maintained on the premises or by an outside service. It has been found necessary that the employee be furnished with this laundry service to assure a supply of clean outer garments when necessary.

Hand washing facilities are placed at many locations throughout the plant. It is imperative that the employee be able to wash his hands should they become soiled before he again handles any food product. The hands are washed in running water from a combination faucet which blends hot and cold water to a temperate degree. The flow of water is controlled by a foot-valve. The foot-valve is preferred to a hand valve since operating valves with soiled hands creates an unclean condition. The faucet discharges the water at a point of approximately 12 inches above the bowl so that the hands and arms may be washed freely without obstruction. Liquid soap is provided in a dispenser that does not become contaminated through repeated use by soiled hands.

Employees' dressing rooms are supplied with abundant natural light and good ventilation. They are separated from adjoining toilet rooms by tight, full-height walls or partitions, and solid, self-closing doors completely filling the doorway opening. Generally, employees are provided with individual lockers for their clothes and other personal belongings. These are made of metal. A locker space is at least $15 \times 18 \times 60$ inches. The lockers are about 16 inches above the floor and supported in a way that permits easy and complete cleaning of the floor underneath. It is preferred that lockers not be placed against walls but rather back to back with adequate passageway between the lockers and the walls and between double rows of lockers. The lockers placed back to back have a single back partition in common. This avoids space which would serve as harborage for insects. When it is necessary to place lockers against a wall the metal locker back is eliminated entirely and the wall serves as the back of the locker. This also avoids providing a harborage for insects. Adequate

lavatories and showers are provided. The lavatories are located in the dressing room immediately adjoining the doorway from the toilet room.

Facilities where employees may eat their lunches are provided either as part of the dressing rooms or as a separate lunch room. Such facilities are necessary so that the employees will not eat their lunch in the meat processing departments. Many insanitary conditions can result from converting meat processing departments into lunchrooms.

Only water closets and urinals are located in the toilet rooms adjoining the dressing rooms. In toilet rooms located throughout the packing plant, lavatories are provided in addition to water closets and urinals. Water closets are provided in sufficient number for the number of employees at the plant at the ratio of 1 unit for each 25 men or 20 women.

Toilet rooms are not entered directly from a workroom but through an intervening dressing room or toilet room vestibule. The doorways in the toilet rooms, dressing rooms and toilet room vestibules are provided with solid, self-closing doors completely filling the doorway openings. The floors of toilet rooms and dressing rooms are of impervious material and pitched about $\frac{1}{8}$ inch per foot to floor drains. If stall-type urinals are provided, the nearby floor is pitched to drain into the urinals. If the urinals are of the wall type, a floor drain is placed under the urinals and adjacent floor is pitched to the drain.

Drinking fountains are available in all dressing rooms and operating departments. They are particularly important in meat processing departments since, in their absence, employees would drink from any available outlet which in many cases would be connected with equipment in which edible products are handled. An employee drinking water from an outlet situated over a vat in which cured hams were soaking, for example, may result in water from the employee's mouth and face contaminating the hams in the vat.

**Cleanup.**—Cleanliness in the packing plants depends on a great many things. It is influenced by the surrounding in which the packing plant is located, the type of construction of the packing plant, the plan of the plant as it relates to volume and kind of meat packing operations, the kind of equipment used and finally, the facilities for cleanup and the cleanup program in the particular plant. Refuse is not permitted to accumulate either in departments of the meat packing plant or on its premises. The frequency of refuse removal depends on the need but it is removed at least once daily.

Outlets for cleanup hoses are located with sufficient frequency throughout the plant that an abundant supply of water is available in all departments where meat is handled and processed. The outlets are numerous enough so that the use of long hoses can be avoided. Long hoses constitute an interference with the movement of traffic throughout operating departments and may cause unclean conditions to develop. Wire brushes and steel wool are not used in cleaning equipment on which meat is handled. Their use might result in contaminating food with wire or particles of steel.

An abundant supply of hot water is essential to adequate cleanup in a packing plant. It is necessary to remove the grease and particles of fat that become lodged on floors, walls, and equipment. Devices for mixing

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cold water and steam at hose outlets for the production of hot water have not proved satisfactory. Hot water is delivered at outlets usually at a temperature of 140° to 150°F. from a central hot water system. When hot water is used for disinfecting purposes its temperature may then be boosted by steam to at least 180°F.

**Equipment Washroom.**—Although cleanup is a progressive practice in the meat processing departments while operations are under way, the washing of equipment adjacent to exposed meat creates an unsatisfactory condition through the contamination of the food by cleanup water splashing into it from the equipment being washed. Accordingly, equipment washrooms are provided in which specialized facilities are installed for cleaning certain kinds of equipment and adequate floor space is provided for cleaning trucks, vats, racks, and the like.

Curing equipment, such as hogsheads and boxes in which bacon is cured, after being emptied of its contents in the curing department is taken to the equipment washroom where it is thoroughly cleaned, and in many cases, sterilized with hot water at 180°F. after which it is returned to the curing cellar and put into use again.

Metal molds used in the preparation of cooked hams and many kinds of meat loaves present a difficult cleaning problem. They are cleaned with equipment provided with revolving brushes rotating in a strong alkali solution; then they are placed in equipment which thoroughly rinses them in sprays of hot water.

Smokesticks from which many kinds of sausage and pork products are hung for smoking are cleaned thoroughly between each batch of smoked product. These are cleaned in the equipment washroom where they are placed in a drum containing a strong alkali solution and then rotated. After this treatment they are rinsed thoroughly in clean, hot water. Gambrels are handled in a similar manner each time they are used.

Trolleys from which carcass meat is suspended in the coolers require special attention. Not only do the hooks become soiled but the trolleys themselves become corroded. It is necessary to remove the corrosion from the trolley at the same time the soilage is cleaned from the hook. Otherwise rust from the trolley would drop on the meat and soil it as the meat on trolleys moves on the rail from the slaughtering department to its destination in a processing department or the shipping dock. An effective system for cleaning trolleys consists of a series of tanks into which the trolleys are dipped. They are usually dipped into these tanks in batches up to 100 and more suspended from a rack. The batch is first lowered into an alkaline cleaning solution heated to a temperature of 180°F. It is allowed to soak for about five minutes and is then lifted out of the tank and permitted to drain before being placed in the next tank which contains fresh rinse water also heated to 180°F. This rinsing can be accomplished just as effectively by using a high pressure hose discharging water at approximately the same temperature. After being rinsed, the trolleys are lowered into a third tank which contains the derusting solution. A wooden tank is used for this purpose; the solution consists of one of the mildly acid detergents. This solution is also held at a temperature of 180°F. and the trolleys are held in it for a sufficient period to remove the rust, which is

usually from five to ten minutes. When all rust and corrosion are removed the trolleys are raised, allowed to drain, and taken to a second rinse tank where they are thoroughly rinsed in fresh, hot water to remove completely any trace of acidity. The final step is a dip in a tank of hot paraffin oil held at about 160°F. Sometimes a small amount of wax is dissolved in this hot paraffin oil to give the trolley a better protective coat. When the trolleys are removed from this tank the hot paraffin and dissolved wax drain off readily, leaving only a very thin coating which is sufficient to protect the surface from rust while awaiting re-use and during their use in the coolers.

Frequently, secondhand shipping containers, usually slack barrels, are reconditioned and cleaned thoroughly for use again as containers of meats. Those that show signs of having been so handled previously as to preclude their being used again as food containers are rejected and removed from the plant along with other refuse. Those that are susceptible of being placed in proper condition are taken to a washroom where mechanical equipment is provided that thoroughly scrubs the container both inside and outside with a strong detergent solution. The container is thoroughly rinsed and disinfected with 180°F. water and then, after drying, presented for inspection before being used.

Corrosion of cleaned metal surfaces of food handling equipment sometimes occurs between the time that it is thoroughly cleaned and when it is again used for handling food. To avoid this corrosion, a thin film of an odorless, tasteless, and colorless mineral oil is applied to the clean metal surface after the equipment has been thoroughly cleaned. Care is exercised to see that excess mineral oil is wiped from the surface with a clean cloth before the equipment is used for handling meats.

**Detergents.**—The most useful property of soap is that when dissolved in water the cleansing or detergent power of the water is much improved. Until the development of synthetic detergents, soap was the only chemically inactive substance that could enhance the cleansing power of water. But soaps have two serious shortcomings. One, that in acid or even neutral solutions soaps are converted into fatty acids. These have no detergent power, they are in fact insoluble in water. Obviously, it is impossible to use soaps in cleaning processes where the presence of acids cannot be avoided. The second shortcoming of soap is that it is very inefficient when the water is "hard." The calcium and magnesium in hard water react with soap to form greasy curds that produce the ring around the bathtub or the dishpan. It is not until all the calcium and magnesium in the water have reacted with a soap that more soap will enable the solution to clean.

Detergents including the synthetic variety may be divided into three groups: the anionic, the cationic, and the non-ionic. The distinction among the three is as follows: when soaps and most of the synthetic detergents are dissolved in water their molecules split into two electrically charged parts or ions. In most cases one of the ionic fragments is composed of just one atom; the other fragment is the much larger remainder of the molecule. The two fragments of a given molecule must be oppositely charged. Which of the two will be positive and which negative depends on the structure of the molecule. In the case of anionic detergents it is the anion, the nega-

tively-charged group, that is the detergent portion of the molecule. Soap and sodium dodecyl sulfate are anionic. In the case of cationic detergents it is the cation, the positively-charged group that is effective in detergency. The nonionic detergents do not ionize; their molecules operate as whole electrically neutral units.

Of the three types of detergents, the anionic is the most widely used. This type performs well and it may be cheaply produced from readily available raw materials. The present cationic detergents on the other hand are too expensive to compete with the anionic for most purposes. But most of the cationic have germicidal properties that make them useful for special applications. The non-ionic detergents are the newest of the three types. They are cheap and have good detergent properties. They are being produced in increasing quantities and should eventually come into competition with the anionic for certain purposes. The big disadvantage of non-ionics is that they are usually viscous liquids, which, for various reasons are not easily marketed.

All detergent molecules have a significant feature in common. They are made up of a long hydrocarbon chain which is hydrophobic, or water-hating, and a smaller group of atoms which is hydrophilic, or water-loving. In the anionic detergents the sodium carboxylate, the sulfur-oxygen-sodium, or a similar group is hydrophilic. In the cationics it is the nitrogen-containing part of the molecule that is hydrophilic, and in most non-ionics the part of the molecule that contains oxygen atoms has this property. The hydrophobic-hydrophilic structure is characteristic of all surface active substances. Detergents are only one of these substances; two others are emulsifiers and wetting agents.

As a general rule it can be said that if the hydrophilic tendencies of a substance overpower the hydrophobic ones, it will be too soluble in water and adsorption on the surface will not occur. Thus, the substance will not reduce surface tension. If, on the other hand, the hydrophobic tendencies overpower the hydrophilic, then the substance will probably be insoluble in water. Obviously, a surface-active substance is a nice balance between the two opposing tendencies.

Soaps and synthetic detergents owe their cleansing properties to their surface activity in water. Both of these substances are soluble in water because they split into ions and/or possess hydrophilic groups. But the long, hydrophobic hydrocarbon portion of a detergent molecule exerts considerable pressure to keep it out of solution. Fortunately, there is a compromise which satisfies both the tendency for the hydrophilic portion to dissolve and for the hydrophobic portion to get away from the water. When a detergent is dissolved in water ions are distributed throughout the solution. However, there is a higher than average concentration of large ions on the surface. This excess concentration of ions or molecules at the surface of a solution is called adsorption and it is the basis for surface activity. The adsorbed ions or molecules are so arranged that their hydrophilic portions are in the water and their hydrophobic portions are out of it.

This marshalling of molecules at the surface of a solution lowers its surface tension, which is a measure of its desire to maintain a minimum surface

area. The phenomenom is a result of the fact that the molecules at the surface of a liquid are attracted inward by the other molecules of the liquid much more strongly than they are attracted outward by whatever molecules there are above the surface. It is this inward pull on the surface molecules of free droplets that causes them to assume a spherical shape.

The ions or molecules at the surface of a detergent solution are rather loosely held; indeed their hydrophobic portions would like to leave the solution entirely. This is another way of saying that the surface tension of the solution is lower than it would be if the detergent were not present. It is this low surface tension that enables detergent solutions to wet a variety of surfaces more thoroughly than plain water does. The willingness of such solutions to have their surfaces extended also accounts for the formation of suds.

This rather simplified picture of a detergent solution provides a basis for an understanding of how detergents work. The detergent process is generally thought to consist of the following three operations, (1) thorough wetting of the dirt and the surface by the detergent solution, (2) removing the dirt from the surface, and (3) maintaining the dirt in a stable suspension. The detergent molecules at the surface of a detergent solution would rather be in contact with the dirt than with the air, and because the hydrophobic characteristic of the detergent molecule is attracted to the dirt it acts as a bridge between the dirt and the water. The bridge is joined to the water by the hydrophilic portion of the molecule. It is by this process that a detergent solution wets a dirty surface.

Next, the dirt must be removed. This is usually accomplished by mechanical agitation of one kind or another.

After the dirt has been removed from the surface it must be suspended in the solution and not allowed to redeposit. The mechanism of suspension is not completely understood but is probably as follows: The ions or molecules of the detergent are adsorbed on the surface between the solution and a particle of dirt. The hydrophobic portions of the molecules are pointed toward the dirt, while the charged hydrophilic portions are pointed away from it. The dirt particles are thus covered with a charged layer of detergent molecules. The other particles of dirt in the solution are surrounded by the same kind of charged layer, and since for any given detergent the charge around the particles will have the same sign, the particles mutually repell one another. It is this process that is presumed to keep dirt from coagulating or settling and easy removal of the dirt is accomplished by rinsing.

**Disinfectants.**—Equipment that has become contaminated with diseased material is first cleaned thoroughly in a place specifically provided and is connected directly to the sewer. Then the equipment is disinfected by subjecting all of its surface to thorough flushing with water heated to 180°F.

Disinfection of other equipment is commonly practiced. A meat processing department and food handling equipment in the department sometimes become contaminated with an organism that withstands the most thorough cleaning practices. It is necessary, then, to disinfect all surfaces of the equipment and the floors, walls, ceilings and other exposed

surfaces. Aqueous solutions of quaternary ammonium compounds, sodium hypochlorite or chloramine T are used for this purpose. Aqueous solutions of iodine and certain types of non-ionic synthetic detergents as well as hydrogen peroxide are also sometimes used. Before such disinfection is undertaken, it is usually considered to be good practice to remove all meat from the room or compartment. The use of disinfectants is no substitute for thorough cleaning. In fact, their effectiveness is considerably reduced if the surface on which they are used is unclean.

A solution of sodium hypochlorite containing approximately 50 p.p.m. of chlorine is sometimes used as a rinse, after washing, for the hands of employees engaged in handling meat food products. A solution of sodium hypochlorite containing 200 p.p.m. of chlorine is used effectively to disinfect equipment.

The strength of the solution of quaternary ammonium compounds customarily does not exceed 1 oz. of a 10 per cent aqueous solution or 1/10 oz. of the dry material to 4 gallons of water. The concentrated solutions and the dry chemical are handled with care because they are extremely irritating to the mucous membranes. The solution of sodium hypochlorite or chloramine customarily used contains ½ of 1 per cent available chlorine (5,000 parts per million). Disinfectant solutions are allowed to remain on the equipment until it is again used when the residue is thoroughly rinsed from all surfaces that may contact food. The residue is permitted to remain on the floors, walls, and ceilings where it may exercise a continuing action.

Steam usually referred to as live steam does not have in practice that sterilizing value which it would appear to have in theory. As live steam is discharged from a pipe or hose it very quickly loses its pressure and its temperature drops sharply. Within a very short distance, a matter of a few inches, the steam has turned to merely a warm vapor. The temperature of steam can be best used for disinfection purposes by discharging it into water already heated to a temperature of approximately 140°F. The steam will boost the temperature of the water readily to a disinfecting temperature of 180°F.

Of the chemical sanitizers available for the food processing plant, the hypochlorites and quaternary ammonium compounds are most commonly used. These two disinfectants differ somewhat in mode of action. The activity of hypochlorites is believed to center on certain essential enzyme systems of bacteria. The quaternary ammonium compounds also are believed to act on certain enzyme systems but in addition, there is evidence to indicate that they exercise an effect on the cell surface that contributes to their disinfectant action. The type of organism and the pH of the medium have a marked influence on the relative activity of quaternary ammonium compounds. The pseudomonas fluorescents, for example, show high susceptibility to the quaternaries at low pH levels and fairly high resistance at high pH levels. On the other hand, E. coli may show high resistance at a low pH level and greater susceptibility to the germicidal action of the quaternaries at higher pH levels. At pH levels near or slightly above neutral at which the quaternaries are usually used, species like the pseudonomas and escherichia, may show relatively high resistance to

quaternary compounds. The micrococci may, on the other hand, show relatively great susceptibility under these conditions. The hypochlorites are less selective in their effect on different species of bacteria. However, the hypochlorites are more active at low pH levels and their activity decreases as the pH increases.

Organic matter inactivates both hypochlorites and quaternary compounds, although the latter appear to be less susceptible than the former. Activity of the quaternaries is adversely affected by hard water salts, such as calcium, magnesium and iron, by soaps, and by anionic surface-active agents.

The quaternary ammonium compounds respond favorably to the addition of certain potentiating agents. For example, the presence of polyphosphates in the solution may greatly accelerate the effectiveness of the quaternary compounds against various species of bacteria. An important quality of the quaternaries is their ability to form a fairly stable film that exercises a continuing bacteriostatic effect on the surface of equipment or utensils. This film is non-corrosive.

Since the hypochlorites are less selective in their effect on various species of bacteria and provide more rapid destruction under most conditions for the greater variety of microorganisms, the hypochlorites are preferred for sanitation of equipment immediately prior to its use. The quaternaries are preferred when a bacteriostatic film is desired for the surface of equipment that is to stand idle.

**Equipment.**—Equipment used in the packinghouse for the handling and preparation of meat and its products is so constructed and maintained as not to constitute a source of contamination for the food. Furthermore, it is so installed as not to interfere with the maintenance of clean conditions in the surrounding area. The equipment is constructed of material that presents a smooth, impervious surface free from crevices, seams, or joints in which food may lodge, decompose, and support the growth of organisms. All parts of the equipment are accessible for cleaning. The equipment is so located with respect to fixed objects, such as floors, walls, pillars, and other pieces of equipment, to permit ready and thorough cleanup following the day's operations.

Wood is not a satisfactory material for use in constructing equipment for handling meat or its products. Its surface does not remain smooth, neither is it impervious. Nevertheless, it is necessary to provide a wood surface where meat cutting is done. Cutting blocks are used for this purpose and constitute a removable part of equipment the remainder of which is metal.

Enameled surfaces, although smooth and impervious, are not satisfactory for meat handling or processing equipment, since particles of the enamel easily chip off and may contaminate the food. Painted surfaces on equipment are even more objectionable since they are less permanent and the paint readily contaminates the food.

Copper at one time was a favorite material for use in making kettles since it lent itself nicely to the metal worker's art. Also, many pipe fittings have been and still are made of copper. Copper is not a satisfactory surface for food-handling equipment since it discolors the food in some

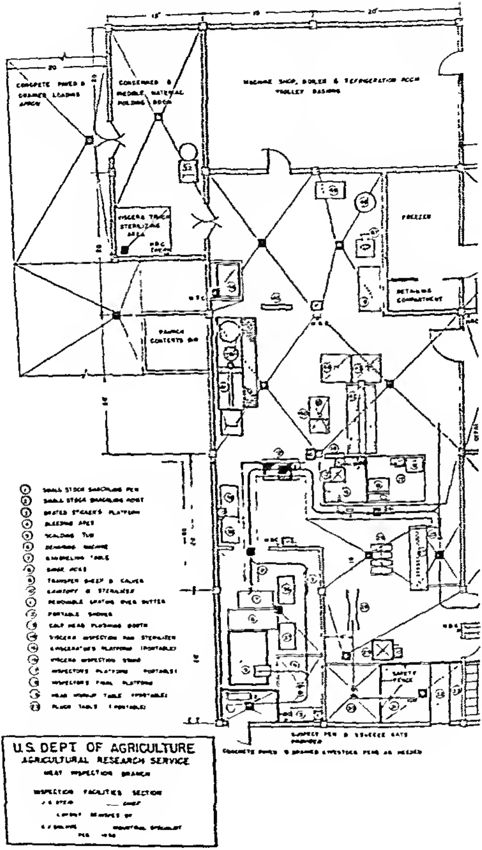

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Fig. 70.

## SUGGESTED SMALL PLANT LAYOUT

THIS SUGGESTED SLAUGHTERING LAYOUT IS DESIGNED FOR A SMALL OPERATOR WHO SLAUGHTERS APPROXIMATELY 100 CATTLE AND 300 HEAD OF SMALL STOCK WEEKLY. THE FULL CAPACITY OF THIS SLAUGHTERING LAYOUT IS APPROXIMATELY 10 CATTLE OR 20 HEAD OF SMALL STOCK PER HOUR. FOR CONSTRUCTION DETAILS, LIGHTING AND VENTILATING REQUIREMENTS AND NECESSARY RAIL HEIGHTS, REFER TO THE LATEST EDITION OF THE BOOKLET INFORMATION FOR APPLICANTS FOR FEDERAL MEAT INSPECTION.

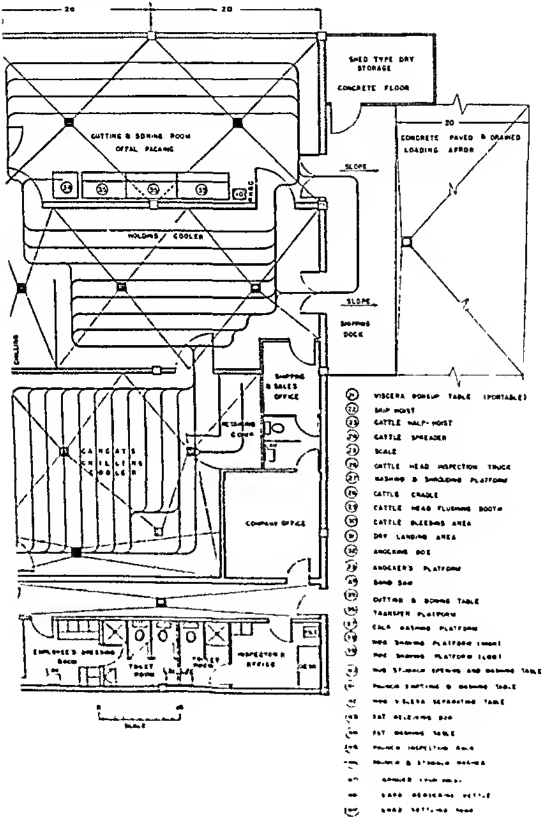


Fig. 70 - (Continued).

instances, contaminates it with its salts, and tends to catalyze fat deterioration. Copper kettles are acceptable for use after being tinned on their inside so long as the tin coating remains intact.

Tin coated metal surfaces are satisfactory for food handling equipment as are those coated with zinc (galvanized). Galvanized metal equipment is the more popular of the two; however, both coatings wear off and must be replaced from time to time. As the coatings wear off, the unprotected steel or iron surface cannot be kept clean and sanitary because of a rapidly progressive corrosion that occurs under packinghouse conditions.

Some use has been made of plastics to coat metal surfaces. Properly applied synthetic resin lacquers have been found to work satisfactorily when applied to the surface of metal equipment that is used for certain purposes. These resin coatings have not proved to be useful on meat trucks and similar equipment that is customarily subjected to hard usage and frequent contact with metal tools. Vinyl coatings have been found too soft and phenolic coatings too brittle.

So-called stainless steel is the most satisfactory material with which to construct equipment for the handling and processing of meat and its products. Its surface is bright, smooth, and impervious, and it approaches complete resistance to atmospheric corrosion. It is a chromium and nickel alloy of iron. Several such alloys are made, each for a particular purpose. The alloy containing approximately 18 per cent chromium and 8 per cent nickel with a carbon content below .15 per cent is the one best suited for meat handling equipment. Chromium is the only alloy which has been found to produce in iron alloys a metal with a surface completely resistant to atmospheric corrosion. At least 11 per cent of chromium is necessary to accomplish this effect. The addition of nickel in substantial proportions to the chromium-iron system provides a series of alloys with more pronounced resistance to many kinds of corrosive attack, and at the same time introduces important advantages with respect to the physical or mechanical properties of the metal. These alloys have higher tensile strength than have ordinary steels of the same carbon content. The one containing 18 per cent of chromium and 8 per cent of nickel that has been found best suited for meat packing house use is non-magnetic and extraordinarily tough and ductile. When proper precautions are followed this alloy will weld without brittleness either by the acetylene, electric arc, or resistance process.

Vats of many kinds are used in meat packing plants. Generally, they are made of metal and are so located and constructed that they can be readily and thoroughly cleaned. Concrete vats have not worked out satisfactorily where the concrete surface is exposed to fats. Fat causes deterioration to set in, the surface of the concrete disintegrates and loses its smooth finish, resulting in a pitted surface which cannot be kept clean.

**Chutes.** – Chutes are used for conveying many types of product from one level to another. They are made demountable so that they can be taken down in segments of convenient size for cleaning, and where they go through the floor the opening is surrounded by a heavy metal flange extending at least 8 inches above the floor level. The segment of the chute which fits into this flange is also removable for cleaning. Chutes that connect

edible products departments with inedible products departments are hooded at the edible end and vented to the outdoors. The product enters the hooded end through a self-closing trap door. This prevents passage of odors from the inedible products department to the edible products department.

Mechanized equipment of many descriptions, such as meat choppers and agitators over fat rendering kettles, requires attention to avoid contamination of food from grease and particles which might drop into it from the overhead gears or motors.

Racks are used in many departments hoth for dry storage and for storage of edible products. These are at least 12 inches ahove the floor and of such size that they can he readily taken to the washroom for cleaning.

Many kinds of valves are used in pipe lines that convey food products. These are demountable for cleaning and so constructed that there are no dead spaces in which food may stagnate and decompose.

There are three general classes of containers in which meat and its products are placed and handled. They are: the so-called operating container which is used to transfer meat from one department to another in the meat packing plant, the so-called shipping container which is used to ship wholesale lots of meat from the plant to the trade, and the true container which is generally the consumer package. The operating container used within the plant is of the same construction as other product-handling equipment. That is, it is one that will stand up under hard usage and keep in a condition which will permit its ready and thorough cleaning. The shipping container is of such construction that it will protect the product under the usual conditions encountered through shipment to the trade. These are usually lightweight wood or cardhoard containers of many kinds. The principal interest is that the material from which these containers are constructed will not contaminate the product packed therein. The paper lining that is frequently used in such containers is of a quality that will not disintegrate and contaminate the food. Sometimes the printing on true containers is not fast and may run and contaminate the food in the container. Attention is given to see that the kind of material from which the true container is made as well as the printing on it is such that the product in the container will not become contaminated enroute to the consumer.

Bursting electric light bulbs, broken window glass, and broken light globes are sources of serious contamination of food with broken glass. All broken window glass is immediately replaced as are broken light globes. All exposed electric light bulbs are protected so that, if broken, the pieces will not drop into any meat or its products.

**Slaughtering Department.**—Because of the nature of the operations performed and the large volume of material handled even in a small slaughtering department, the construction of the department, its arrangement, and its facilities influence significantly the sanitation surrounding the conversion of animals to meat. The walls and floors are impervious and smooth so that they may easily be cleaned. The floors are pitched to drains so located that cleanup may be continuous and progressive during the slaughtering operation without any danger of contaminating

the meat at any stage of its preparation. The overhead structures are so arranged and constructed that they can be readily kept in a clean condition.

The handling of the many kinds of product that are produced incident to the slaughtering and carcass dressing operations is accomplished without resulting in congestion in the department. In large slaughtering departments this is done by providing chutes that convey the various classes of products from the locality where they are produced through the floor of the slaughtering department to other departments where they receive further handling. In slaughtering departments of relatively small capacity

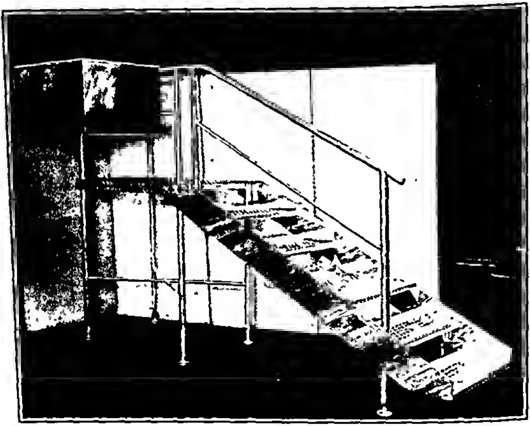

FIG. 71.—Example of sanitary construction in a working platform.

where chutes are not used for conveying the products of the carcass dressing operations, adequate passageway is provided for the movement of hand trucks and other containers used for removing these products from the slaughtering department to the other departments.

The movement of the thoracic and abdominal viscera from the point of evisceration to the place where they are separated into their edible and inedible parts is best initiated by using a "moving table." This moving table consists of an endless chain of flights for cattle viscera or pans for the viscera of small stock. This equipment removes the viscera automatically from the point where evisceration is conducted to the place where the separation operations commence. Viscera inspection is also conducted

on this table. As the flights or pans discharge the viscera and return, they are thoroughly cleaned and disinfected by flushing with water at 180°F.

**Cattle.**—Whether the animal is shackled after knocking which is the common practice for cattle not slaughtered as kosher, or without knocking which is the kosher practice, adequate facilities for restraining the animal are provided. Complete restraint of the animal is of utmost importance so that it may not escape into the slaughtering department. An animal loose in the slaughtering department where the carcass meat is exposed during the various stages of the dressing operations results in the contamination of a considerable amount of meat.

Sufficient space is allowed for bleeding so that blood will be confined to the bleeding area. This area is pitched $\frac{1}{4}''$ to the foot to 2 drains. One drain is the blood line which conveys the blood to the inedible department.

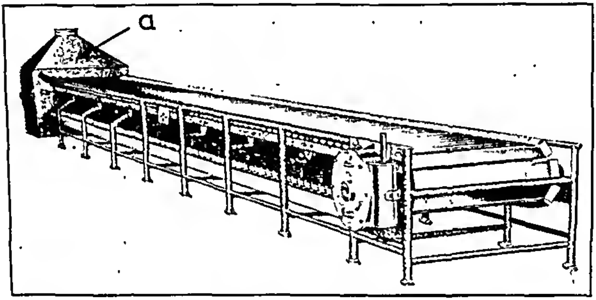


FIG. 72.—Flight top "moving table" for conveying and inspection of cattle viscera: *a*, Disinfecting cabinet.

This is at least a 4 inch line and it is provided with a running U trap which prevents odors from the inedible department passing up the blood line into the slaughtering department. At least a 3 foot drop is provided above the trap to maintain the flow of the blood which tends to coagulate. The other drain is connected with the sewer system and is provided with a cover which is closed except during the cleanup. When the bleeding area is flushed with water as part of the progressive cleanup during the slaughtering operation, the blood line is closed and the water passes down the drain which is connected with the sewer.

A lavatory and sterilizer is provided at the point where the head is removed from the carcass so that the employee who removes the head may wash his hands and disinfect his knife to prevent the carrying of contamination from one head to another. Facilities are provided so that the head as it is removed from the carcass and prepared for inspection may be handled individually to avoid one head contacting another until it has passed the inspection. Facilities are provided for removing the horns and the pieces of skin which are sometimes left on the head when it is skinned. The

equipment used for removing the borns can be readily cleaned and disinfected to avoid carrying contamination from one head to another. Equipment for washing the heads individually is also provided. This usually consists of a cabinet closed on three sides to control the wash water, the head is suspended from a hook where it is washed thoroughly using water under pressure.

The floor pitches both ways from the area in which the carcass is laid for the initial skinning and opening operations. Metal plates having a grilled upper surface and imbedded in the floor have been used extensively to anchor short metal rods that prop the carcass in position for skinning the ventral surface. These "pritch" plates sometimes become loose and a foul condition develops in the space beneath them and the floor. The plates

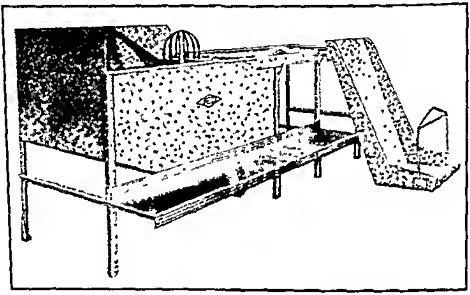

FIG. 73 — Cattle viscera separating equipment with viscera elevator and paunch cleaning attachment. (Albright-Nell Company, Chicago.).

are then taken up and reset to make them tight-fitting. Cradles consisting of a pipe frame in which the carcass is laid for skinning have come into use. These cradles are moveable, and being of pipe construction they are easily cleaned. Their use, furthermore, avoids the installation of the pritch plates and the floor, therefore, is more easily cleaned.

A lavatory and sterilizer is conveniently located for use of the employees who perform the initial skinning of the carcass and conduct the other dressing operations on the carcass as it lies in the cradle. The feet and dewclaws are removed at this position and a container is provided for them in which they are removed from the department.

A lavatory and sterilizer is also provided at the half-hoist position to which the carcass is moved from the dressing bed. The evisceration is performed here and the eviscerator may carry contamination from one carcass to another unless he is able to thoroughly clean his hands and arms and disinfect his equipment. The floor is pitched from the position where the carcass is located on the half-hoist to a floor drain. A cleanup hose is

provided at this point with facilities to furnish water at temperatures ranging up to 180°F. should it become necessary to disinfect the area due to contamination which might occur incident to the evisceration.

As the carcass is raised to the rail on which it travels to the cooler, the hide is completely removed. A chute is provided for the prompt removal of the hide from the slaughtering department. Any attempt to load cattle hides on trucks for removal from the slaughtering department is avoided inasmuch as such handling of the hide creates an unsanitary condition. The area in which the carcasses are washed as their final handling before entering the cooler is pitched to a drain and enclosed to avoid the splashing of wash water from one carcass to another.

**Calves, Sheep, and Goats.**—A mechanical hoist is used to convey the shackled animal to the bleeding rail. When the animal is shackled from an elevated platform it is thrown to the platform as part of the act of shackling; this results in additional soilage of the head and shoulders. When the animal is shackled and is elevated by a mechanical hoist from the floor level, it is immediately raised from a standing position to the bleeding rail without any contamination from the floor of the pen.

The bleeding area is drained similar to that described above for cattle. As the carcass proceeds on the dressing rail, any drip from it is caught in a depressed and drained area in the floor. The surrounding floor area is pitched to this depressed and drained area under the rail. By this arrangement the cleanup of the floor is facilitated.

A lavatory and sterilizer is provided both where the head is removed in the case of calves and where the carcasses of three species are opened for evisceration. Again at the point where the carcasses are eviscerated a lavatory and sterilizer is available for use by the employee who performs the evisceration.

At those positions where the carcasses are washed, the area is enclosed and drained for control of the wash water.

Following are vertical and horizontal distances used in slaughtering departments for calves, sheep, and goats that contribute to the maintenance of clean conditions during the dressing operation:

| *Description* | *Vertical Distances* |
|---|---|
| Bleeding rails for calves (distance from top of rail to point of application of shackle to shackled foot—30") | 11′ 0″ |
| Bleeding rails if only sheep are slaughtered | 9′ 0″ |
| Gambrels or leg hooks from which calf or sheep carcasses are suspended to floor or inspector's foot platform | 7′ 3″ |
| Cooler rails, calf carcasses | Gambrels 7′ 3″ above floor |
| Cooler rails, sheep carcasses on legs | Hooks of legs 6′ 6″ above floor |

| *Description* | *Horizontal Distances* |
|---|---|
| Vertical of rail to edge of viscera inspection stand | 2′ 0″ |
| Length of rail from point of evisceration to point where carcass inspection is completed | 6′ 0″ |

FIG. 74.—Chart showing minimum distances allowed for equipment and operations in calf, sheep and goat slaughtering departments to assure cleanly handling of carcasses during the dressing operation.

**Hogs.**—The shackling and bleeding of hogs creates considerable dust in the air and is quite noisy. The scalding vat and dehairing machine produce considerable heat and vapors in the surrounding area. These operations, therefore, are segregated from the hog dressing department. This is accomplished either by locating them in a separate compartment or by using a partition. There is considerable waste water from the scalding vat and dehairing machine that is caught in an area pitched to the drain and directed to the sewer. Hog hair accumulates rapidly in connection with the dehairing operation and facilities are provided for directing this to a chute which removes it promptly from the department.

As the hog carcasses move along the dressing rail they pass over a drained, depressed area to which the floor is pitched. This directs all drip from the hog carcasses and facilitates the cleanup of the department. Lavatories and sterilizers are provided where the heads are dropped for inspection, where the carcasses are opened for evisceration, and where evisceration is actually conducted. All areas where washing of the hog carcasses is conducted are enclosed and drained to control the wash water.

Following are vertical and horizontal distances that are used in laying out hog slaughtering departments for the purpose of maintaining clean and sanitary conditions:

| *Description* | *Vertical Distances* |
|---|---|
| Bleeding rail to sticker's platform | 10′ 6″ |
| Extension of bleeding rail to top edge of scalding vat | 9′ 0″ |
| Dressing rails | 11′ 0″ |
| Gambrels (suspending carcasses) to floor (12″ trolleys) | 10′ 0″ |
| Rails in coolers for hog carcasses with heads removed (12″ trolleys) | 9′ 0″ |
| Rails in coolers for carcasses with heads attached (12″ trolleys) | 10′ 0″ |

FIG. 75.—Chart showing minimum distances allowed for equipment and operations in hog slaughtering departments to assure cleanly handling of carcasses during the dressing operation.

**Poultry.**—Scalding tanks are constructed and installed so as to preven. contamination of potable waterlines and to permit water to enter contint uously at a rate which will accomplish a satisfactory scalding operation. The rate of flow necessary to maintain a sanitary scalding operation is determined by such factors as class of poultry and the number of birds a minute going into the scalding tank. The overflow outlet in scalding equipment is of sufficient size to permit feathers and water to be carried away. The overflow, draw-off valves, and sediment basin drain discharge into the floor or valley drain.

When individual trays are used during eviscerating operations, each carcass is suspended and a trough of impervious material is provided beneath the conveyor to extend from the point where the carcass was opened to the point where viscera has been completely removed. Such troughs are flushed continuously by a water spray.

Chilling tanks are constructed of metal and are seamless construction with edges rolled outward. Where mechanical devices are not used for removing carcasses from the chilling tanks, the tanks are of a size that will enable employees to remove poultry without getting inside the tank.

Inspection, eviscerating, and cutting tables are made of metal, have coved corners, and are so constructed and placed as to permit thorough cleaning.

Water spray washing equipment with adequate water pressure is provided to wash thoroughly and efficiently carcasses both inside and outside.

Watertight metal receptacles are provided for viscera and other waste resulting from the poultry eviscerating operation.

Watertight trucks or receptables are provided for holding and handling diseased carcasses and diseased parts of carcasses. These are conspicuously marked with the word "Condemned" prominently displayed.

When mechanical pickers are used, they are so installed as to be accessible for thorough cleaning and removal of the accumulation of feathers.

**Viscera Separating.**—The handling of the thoracic viscera does not present any special problem. Separating it into its various edible parts can be accomplished in a clean manner using tables and conveyors of a construction that can be readily maintained in a clean and sanitary condition. The separation of the abdominal viscera is a more difficult problem principally because of the necessity for taking precautions at each step to avoid contamination of the edible portions with the contents of the digestive tract.

Facilities that are adequate to properly handle the abdominal viscera are provided from the point of evisceration to the final production of edible and inedible products resulting from the separating of the viscera into its various parts. The viscera separatiug operations are conducted as close to the point of evisceration as is physically possible depending on the rate of slaughter. The flow of operations constituting the separating process is continuous and there is a minimum amount of manipulation incident to the operation. The transportation and manipulation of abdominal viscera with its digestive tract contents can be accomplished in a clean manner only with the utmost of care.

The walls and floor are impervious and smooth. The floor is pitched to drains so located that cleanup is facilitated. A water outlet or outlets are provided depending on the size of the department, for cleanup hose connections:

**Cattle.**—The cattle carcass is eviscerated directly into a truck in the case of a small slaughtering production or for large production on "a moving table." At the time of evisceration the viscera is separated into four parts: the thoracic portion, the liver, and two abdominal portions. One abdominal portion includes the four stomachs and theother the small and large intestiues. The viscera is transported by the truck or moving table to the point where the separation operations commence.

The stomach portion is placed on a table sufficiently large to handle the volume of operations. In no case are the stomachs permitted to accumulate preparatory to handling. The table is large enough to accommodate the number of workmen necessary to handle the particular production. Over the table are water outlets having spray attachments that can be used to immediately remove any soilage which might occur through seepage of digestive contents prior to its evacuation. The caul (omental) fat is removed from the stomach portion and a receptacle is provided for its

cleanly handling and transportation to the rendering department. At the same time fat called "seam fat" is trimmed from the surface of the omasum and abomasum. This fat is also handled in a clean manner along with the caul fat. The stomach portion is then separated into a portion consisting of the omasum and abomasum which are discarded as inedible and the portion consisting of the rumen and reticulum are handled as edible. The omasum and abomasum are placed either directly into a chute which conveys them to the inedible products department or in a truck which is used exclusively for inedible products.

*Cattle Slaughtering Departments*

| *Description* | *Vertical Distances* |
|---|---|
| Bleeding rail (distance from rail to point of application of shackle to shackled foot—48") | 16′ 0″ |
| Dressing rails (trolley length—15") | 11′ 0″ |
| Beef cooler rails (trolley length—15") | 11′ 0″ |
| Rails for beef in quarters (trolley length—15") | 7′ 2″ |
| ***Description*** | ***Horizontal Distances*** |
| Dry area in front of knocking pen | 5′ × 8′ |
| Curb of bleeding area to pritch plates (no header rail) | 5′ 0″ |
| Line of drop-offs to line of half hoists (2 beds) | 16′ 0″ |
| Line of drop-offs to line of half hoists (3 beds or more) | 18′ 0″ |
| Line of half hoists to header rail leading to cooler | 14′ 0″ |
| Between header rail and carcass washing rail, if parallel | 6′ 0″ |
| Between header or washing rails and wall of slaughtering room | 3′ 0″ |
| Between center lines of dressing beds | 8′ 0″ |
| Between pairs of dressing rails | 4′ 0″ |
| Between moving top table and dressing rail at inspector's platform | 5′ 6″ |
| Area for sterilizing viscera inspection truck | 7′ × 8′ |

FIG. 76.—Principal Minimum Distances. (Rail heights are measured from top of rail to highest part of floor.)

The rumen and reticulum are moved to the end of the table where there is a hopper connected directly with the sewer and provided with a water standpipe. The contents of the rumen and reticulum are evacuated directly into this hopper and the emptied stomachs are placed over the standpipe which thoroughly flushes them of their digestive contents. Next, there is provided a metal standard resembling an umbrella in shape and size. The rumen and reticulum which have been thoroughly flushed of their contents are handled as a unit and spread over the convex top of this equipment. They are thoroughly washed on both the peritoneal and mucous sides under a water spray. At this point the portions which cannot be washed clean are trimmed and discarded. The clean rumen and reticulum go into the preparation of tripe.

The intestinal portion of the abdominal viscera is placed on another table which is also equipped with overhead water outlets for use in washing away any seepage of intestinal contents. Here again the table is large enough to accommodate the number of employees necessary to take care

of the production without piling up of the viscera. First, the small intestine is removed from the mesenteric fat. Beginning at the duodenal end, the intestine is cut from the fat at its attachment. The loose intestine as it is separated drops to a perforated metal surface over which a spray of water continuously plays. When the employee removing the intestine reaches the halfway point, he loops the loose end on a conveyor belt which carries the intestine through a stripping machine between two metal rollers. A hopper directly connected with the sewer is provided under the perforated metal tray and as the intestine is carried into the stripper it passes over

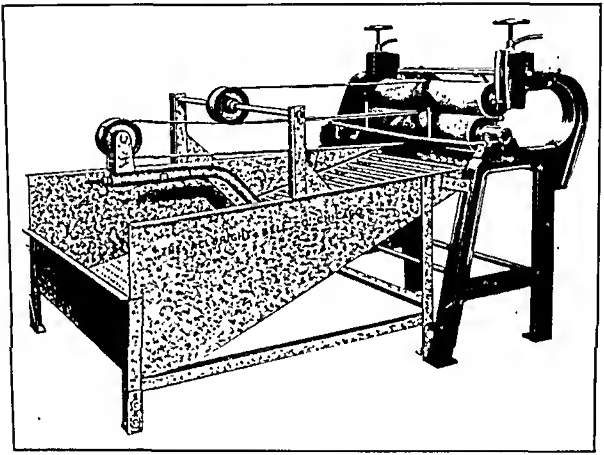

FIG. 77.—Equipment for stripping small intestines free of their contents preparatory to converting intestines to casings.

metal bars which permit the intestinal contents to drop through to this same hopper. In this manner the small intestine is separated from the abdominal viscera and stripped of its contents without contamination and immediate removal of its contents to the sewer.

The cecum is next removed from the abdominal viscera and its contents are thoroughly flushed from it by placing it over a standpipe that discharges water into it.

The remaining portion consists of the mesenteric fat and the large intestine minus the cecum. The lumen of the large intestine is flushed entirely clean of its contents by directing water under pressure into it at one end and discharging the other end directly into a hopper connected with the sewer. The large intestine is then pulled free from the mesenteric fat.

After being examined carefully for any possible soilage the mesenteric fat is conveyed to the rendering department.

**Calves, Sheep, and Goats.**—The viscera is separated into three parts consisting of the thoracic portion with the liver attached and two abdominal portions. The two abdominal portions, because of the contents of their digestive tract, are required to be handled in such a way that there will be no contamination of the edible portions.

Generally, the only part of the stomach portion that is saved for food is the caul fat. Occasionally the rumen and reticulum of calves, sheep, or goats are saved for human food in which case they are handled the same as the comparable organs of cattle are handled. The abomasum of very young calves is sometimes saved for the manufacture of rennin.

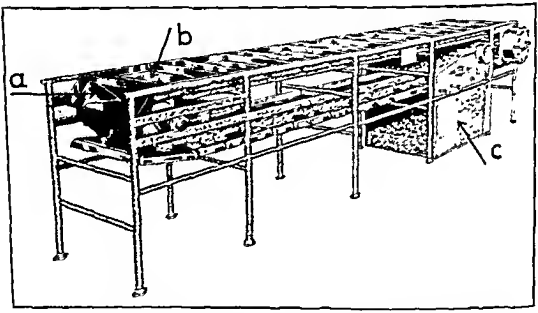


FIG. 78.—Pan type "moving table" for conveying and inspection of hog viscera and hog heads: *a*, Pan for holding the head; *b*, pan for viscera; *c*, disinfecting cabinet.

The small intestine is pulled from the mesenteric fat. It is conveyed mechanically through a stripper between two metallic rollers. As the intestines are conveyed to the stripper they pass under sprays of water which wash their contents directly into a hopper connected with the sewer.

The large intestines are not usually saved for any edible purpose. The mesenteric fat is removed from the large intestine. This fat is examined for cleanliness after which it is removed to the edible rendering department. The large intestine with its contents is removed to the inedible products rendering department.

**Hogs.**—The thoracic and abdominal viscera are removed intact from the hog carcass. In a plant of large production, the viscera is carried on a moving table from the point of evisceration to the place where the viscera separation begins. In a small plant, the viscera is first placed in a pan for inspection after which it is lifted to a table for separation into its various

parts. First, the lungs are removed and handled as inedible. Next, the heart, liver, and spleen are removed and saved as edible products.

Of the abdominal viscera, the stomach is first removed and immediately emptied of its contents. The stomach is emptied into a hopper directly connected with the sewer and provided with a water standpipe over which it is thoroughly washed both inside and outside. Each stomach is thoroughly cleaned individually if it is to be saved as an edible product. The caul fat is removed at the same time as the stomach and it is examined thoroughly for cleanliness before it is conveyed to the edible rendering department.

The small intestines are then pulled from their attachment to the mesenteric fat. As the intestine is pulled, it is conveyed directly through a stripper which squeezes out its contents between two metal rolls. The intestine is conveyed to the stripper under water sprays and as the intestine approaches the stripper it passes over bars placed at right angles to the intestine which permits the intestinal contents to drop into a hopper directly connected with the sewer.

When portions of the large intestine are saved for chitterlings, they are flushed of their contents and after being opened for their entire length they are thoroughly cleaned both inside and outside. The terminal portion of the large intestine of larger sizes is sometimes saved for casing manufacture after being thoroughly flushed of its contents. In any case, the large intestine is removed from the mesenteric fat and this fat, after being examined for cleanliness, is taken to the edible rendering products department.

**Refrigerating Departments.**—Fresh meat is chilled as rapidly as possible and this constitutes the only method of combating spoilage and decomposition that does not change the character of the meat. Other methods of preventing spoilage and decomposition of meat, such as by salting, smoking, or drying, alter its character. The chilling is done promptly and thoroughly to reach a temperature not higher than 32° to 35°F. throughout the meat in what is called the initial stationary phase during which there is no bacterial increase. The refrigeration facilities, therefore, are adequate to handle the maximum meat production for the particular plant. There is refrigerated space available for each carcass immediately after completing the dressing operation and sufficient room in the refrigerated space to permit placing the carcasses so that there may be free circulation of air between them.

**Refrigeration.**—Mechanical refrigeration has entirely replaced natural ice in the packing industry in the United States. There were a few remaining large refrigerated rooms for meat using natural ice until as late as the 1920's. Large quantities of ice were placed in drained waterproof overhead bunkers. Such a bunker would have a high side and a low side. The warm air would rise in the space between the wall of the cooler and the high side of the bunker passing over the top of the side into the bunker where it would be chilled by coming in contact with the ice and the chilled air would drop over the low side of the bunker into the space where the meat was hung. This same air movement occurs where refrigeration coils are in the bunkers.

Mechanical refrigeration is based primarily on the principle that to convert a liquid to a gas requires the expenditure of a definite amount of energy. This energy is in the form of heat. There are two measures of heat, one deals with the intensity of heat, the other with its quantity. Temperature is a measure of intensity and is expressed usually in degrees Fahrenheit or degrees Centigrade as registered by a thermometer. The quantity of heat is measured by British Thermal Units. A B.T.U. is the quantity of heat necessary to raise the temperature of 1 pound of water 1°F.

It requires heat to melt ice or boil a liquid and change it to vapor. When such change is brought about the necessary heat must be forthcoming from some source. In the case of refrigeration the heat is absorbed from the surrounding objects and, of course, the temperature of those objects is thereby lowered. The heat required to change a liquid into gas is called "latent heat" or internal heat to distinguish it from "sensible" or observable heat. The latent heat required varies with different substances. For vaporizing water it is 970 heat units; for ammonia it is 555 heat units; for sulphur dioxide about 170 heat units.

Liquid anhydrous ammonia under 180 pounds pressure will boil at 95° F., under 100 pounds pressure it will boil at 64°F., under 15.65 pounds at 0°F., and under atmospheric pressure it will boil at minus 27°F. Liquid anhydrous ammonia can be made to boil or vaporize by simply lowering its pressure which is another principle made use of in refrigeration since it must absorb heat when it boils.

Conversely, when ammonia gas is compressed by putting it under increased pressure, its temperature will rise. If, then, while still under pressure its temperature is reduced to a definite critical point by a cooling medium and if its latent heat is extracted, the gas will return to a liquid. This is what happens in an ammonia condenser.

It is possible to use for a refrigerant any substance which exists as a liquid at normal temperature and at either high or low pressure, and which exists as a vapor at low temperature and low pressure. There are a number of substances in use as refrigerants but, for several reasons, anhydrous ammonia is best adapted for most cases and is most generally used commercially.

There are two general systems of ammonia refrigeration, namely, the compression system and the absorption system. In an ordinary compression system of refrigeration the cycle of operations is as follows: Liquid ammonia in the liquid receiver is forced under relatively high pressure through a pipe to a valve called the expansion valve which is located at the entrance to the cooling coils in the medium to be refrigerated. When the expansion valve is partially opened the liquid ammonia is allowed to flow into the lower pressure of the cooling coils, and the ammonia is released of the high pressure, it immediately begins to boil and in doing so absorbs enough heat from the medium to supply the latent heat necessary to vaporize the ammonia. The ammonia vapor thus formed flows at low pressure through the main suction pipe to the ammonia compressor. In the compressor the gas is compressed into smaller volume which raises its pressure and temperature. This hot gas is discharged into the ammonia condenser which consists of a bank of pipe coils over which cold water is

showered to cool the ammonia. The water absorbs the latent heat of the hot high pressure ammonia gas and it goes back to the liquid state flowing under pressure into the liquid ammonia receiver completing the cycle.

The absorption system starts the same way with liquid ammonia in the receiver under high pressure. The liquid ammonia is allowed to expand in the same way in the cooling coils at a reduced pressure. It vaporizes and takes up heat the same as in the compression system. From this point on the operation is somewhat different. The low pressure ammonia gas is drawn through the suction pipe to an absorber in which there is a weak solution of ammonia in water. Here the gas is absorbed in the water, producing a strong solution of ammonia. From the absorber the strong solution of ammonia is pumped to a generator which is a steel cylinder containing steam coils. In this cylinder the strong ammonia solution is heated and the ammonia gas is driven off at high temperature under pressure leaving a weak ammonia solution behind. The ammonia gas is condensed in a pipe coil condenser under a spray of cold water the same as in the compression system and the liquid anhydrous ammonia under pressure returns to the receiver completing the cycle. When the ammonia vapor is being absorbed in the absorber it gives off its latent heat of vaporization and the absorber is kept cool by a circulation of cold water. The weak ammonia solution left in the generator is returned to the absorber to absorb more ammonia gas. In the absorption system the absorber takes the place of the ammonia compressor used in the compression system.

In refrigerating systems in which it is not desirable to expand the ammonia directly in the piping in the coolers, the coils are located in a tank of salt brine, or calcium chloride brine which is chilled to low temperatures and the brine then used as the refrigerant. Salt brine of 1.2 specific gravity will freeze at 0°F. Calcium chloride brine of 1.2 specific gravity will freeze at − 10°F. At 1.25 specific gravity calcium chloride brine will freeze at −32°F. and is sometimes used to maintain freezers as low as −25°F.

**Brine Sprays.**—A high rate of refrigeration is obtained by using a spray of refrigerated brine. Quick chilling is accomplished by rapid circulation of air at low temperatures and this is done efficiently by sprays of refrigerated brine that have a strong inductive action. Their effectiveness is due to the large aggregate surface of the innumerable droplets which make intimate contact with the air through which they move.

Brine sprays are used in unit coolers, overhead ducts or decks, and in vertical side wall chambers. The vertical side wall chambers are used when there is not enough head room available for overhead installations. The brine spray nozzles are located at the top of such a chamber and the spray is directed downward. The air is drawn in through the top of the chamber by the downward motion of the spray and becomes chilled as it passes through the spray and is discharged from the bottom of the chamber.

Brine sprays in overhead installations such as ducts and decks are adjusted so that the spray will not overshoot the duct or deck and pass down into the room with the chilled air. This system is not effective when the ducts are short or the decks are narrow. In any case, the system requires constant attention to avoid the brine spray contaminating meat

and to control the corrosion of metal equipment in the refrigerated compartment.

The spray ducts and decks are well insulated. If not well insulated the warm air from the carcasses will strike the lower side of the duct or deck condensing the moisture from the warm air and the condensate will drip on the meat. This equipment is also carefully waterproofed to avoid leaks.

Because of the difficulty of controlling the brine spray in the vertical side chambers and in the ducts and decks to avoid contamination of meat with brine and the excessive corrosion of metal, this type of refrigeration is gradually being replaced by unit coolers. These coolers discharge refrigerated air at high velocity. This accomplishes an effective chilling of the meat and it avoids the condensation of moisture on the walls, ceilings, and equipment which is usually difficult to control in most refrigrated spaces. These unit coolers operate by blowing air past refrigeration coils in a metal housing. Refrigerated brine is showered over the coils to keep them defrosted and this brine is collected in a reservoir and used again and again. The cooler is equipped to eliminate any brine which might be picked up by the air as it passes the coils and before the air is discharged into the room. The units are made of non-corrosive metal which facilitates their cleaning and they are installed in the vicinity of a floor drain which controls any liquids which might escape during their operation.

Unit coolers discharging refrigerated air at high velocity present an additional defrosting problem. This is true particularly of such units used in freezer rooms. Ethylene glycol has proved to be an effective defrosting agent. However, care must be exercised to assure against the ethylene glycol entering the room atmosphere. Investigations have indicated that no harmful amount of ethylene glycol will be present in the atmosphere of the room if the temperature of the air at the discharge point from the blower is not higher than 10° F.

**Defrosting.**—When the refrigeration coils are used as the source of refrigeration in a cooler they require periodic defrosting. This is usually accomplished by turning off the refrigeration and manually removing the accumulated ice from the coils. The meat in the cooler is protected from contamination that might result from this ice falling on it. This is accomplished by having the refrigeration coils when located overhead placed in watertight bunkers so equipped that the accumulation of ice can be removed without passing through the area in which the meat is located and these bunkers are also supplied with drains for carrying off the water from the melted ice. The refrigeration coils are sometimes lined up against the walls of the cooler. In such cases they are placed over a curbed and drained area which confines the ice and drains off the water accumulating from the melted ice.

The gutters beneath wall refrigeration coils in freezers tend to become cluttered with snow and ice when the coils are defrosted. This can be overcome by providing a heating unit for the gutters. Such gutters are constructed with a ¾ inch hot water line embedded about 1½ inches below the gutter surface.

During the defrosting, water at approximately 150° F. is run through the

hot water line embedded in the gutter until the gutter is completely clean of ice and snow. This usually requires about one-half hour, unless an especially large amount of snow and ice has been allowed to accumulate. When properly used, this gutter warming device does not adversely affect the refrigeration in the area.

**Carcass Cutting.**—The cutting of carcasses into their primal parts is done under refrigeration so that the meat will not lose its chill as it is prepared for distribution to the trade. The rail heights for conveying the carcasses through the refrigerated compartment are the same as those given for the slaughtering department. The rails are cleaned regularly to eliminate any corrosion or any particles which might drop onto and

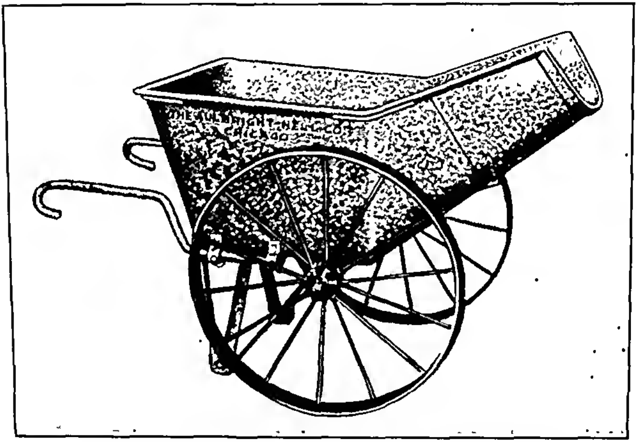

FIG. 79.—Truck of metal construction used for transporting edible fats from the slaughtering and cutting departments to the rendering department.

contaminate the meat as it is conveyed suspended from trolleys. The cutting tables and other equipment used for handling the meat are made of rust-resistant metal provided with removable cutting boards. The metal equipment and the cutting boards are of such size as to permit their being easily handled and readily cleaned. The floors are provided with drains so located as to facilitate hosing down the floor periodically, and conveniently located hose outlets are provided for this purpose. Sawdust is not used on the floors in departments where meat is chilled or cut. Sawdust is a source of contamination of the meat with dust raised by the movement of men or meat handling equipment. It also interferes with cleaning the floor by washing.

As the carcasses are cut into their primal parts, meat cuts and trimmings accumulate rapidly. Sufficient equipment for handling the products of the meat cutting operation is necessary and adequate floor space for the equipment is provided.

Small containers of hot water are provided to free the butchers' knives of accumulations of fat. These containers require attention to maintain them in a clean condition and the insulation of the steam pipes used to heat the water is protected to avoid its becoming soiled and grease soaked.

Meat cuts and meat trimmings are frequently packed directly in shipping containers in the meat cutting department. Space for holding a day's supply of these containers is provided so that they will not become soiled before being used. Only clean containers are used, and strong, water resistant paper is employed to protect the meat from rough wood surfaces such as the inside of slack barrels or from the lint of burlap covers.

**Edible Rendering Department.**—The clean, edible fats derived in connection with the dressing of the carcasses in the slaughtering department and from the cutting of the chilled carcasses into their various parts are brought to this department to be converted into edible rendered fats such as lard and oleo stock. The edible fats are transported to the rendering department either by trucks or chutes. The trucks are of metal construction and of the kind that can be readily maintained in a clean condition. The chutes are also of metal construction and consist of sections that are demountable and easily handled for daily cleaning.

The rendering equipment is of sufficient capacity to readily accommodate the volume of edible fat produced in the plant and this refers particularly to the fats derived from the carcass dressing operation which retain their body heat and will decompose quickly if not rendered promptly. It is important that the production of edible fat from the cutting department move promptly into the rendering tanks since it otherwise tends to cause congestion in the refrigerated compartments and it cannot be permitted to stand around in unrefrigerated areas where it will lose its chill and deterioration set in.

The equipment used for handling the edible fats and the location as well as the design of the charging opening of the rendering tank are such as to facilitate the transfer of the edible fat into the tank without danger of spillage and resultant contamination of the fat by contacting the floor.

The charging opening or head of the tank is usually located one floor level higher than the body of the rendering tank to facilitate the loading operation. The head of the tank extends up through an opening in the floor with several inches of clearance between it and the sides of the opening. The floor surrounding the opening is provided with a flange extending at least 8 inches above the floor level. This construction avoids any floor liquids from the higher floor level passing down through the opening to the lower floor level. It also permits vibration of the tank which frequently occurs during the rendering operation and facilitates the cleanup where the tank passes through the floor. Experience with heads of tanks set solid in the floor has been unsatisfactory since the vibration of the tank tends to open up the seal between the side of the tank and the floor resulting ı the seepage of liquids down around the tank creating an insanitary

condition with the leaking of floor liquids from the high level to the floor below and an unclean condition where the head of the tank passes through the floor.

**Rendering Equipment.**—*Open Kettle.*—This consists of a large steam jacketed kettle open at the top. The raw fats are hashed before being placed

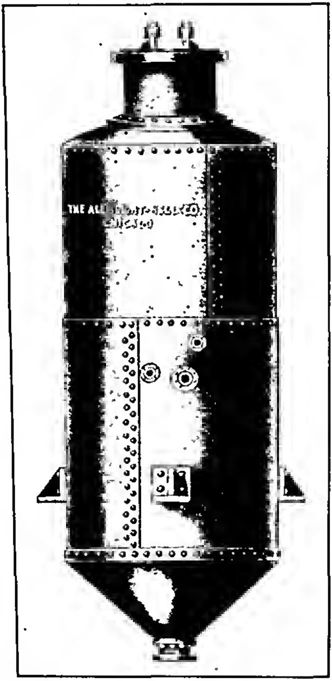

FIG. 80.—So-called "steam rendering tanks" used for rendering fats by injection of steam directly into the contents.

in the kettle and as the fat is rendered from the tissue by the heat from the steam jacket, the moisture passes off to the air. Generally, there is some agitation of the fat while it is being rendered. The rendering is complete when the moisture has been completely cooked away and the rendered fat separated from the dry tissue fibers. This method of rendering is employed in preparing kettle rendered lard.

Another type of open kettle is used in rendering oleo stock from edible beef and mutton fats. These kettles are provided with a hot water jacket instead of a steam jacket. The fresh fats are hashed before being placed in the kettle and are agitated during the rendering process. The object is merely to separate the rendered fat from the animal tissues by heating without any attempt to drive off the moisture. The moisture and tissues are settled out by scattering salt over the surface of the rendered mass and the supernatant rendered fat is drawn off.

The agitators used in this type of rendering equipment usually consist of paddles that revolve about a vertical shaft. This shaft is motivated by overhead gears. The overhead gears and shafts require attention to keep them free of particles that might drop into and contaminate the edible product being rendered in the tank, and drip pans are provided to catch any oil that might otherwise drop into the tank. These drip pans are given regular attention to see that they are properly located and in place, and that they are kept free of extensive accumulations of oil and other débris.

Where vats of cold water are used to chill and float the fresh fats to the hasher and open kettles, the water is changed at frequent and regular intervals to assure that it is always clean and fresh and the tanks are of such construction that they can be readily cleaned. Attention is given particularly to cleaning the refrigeration coils that are submerged in the water. Not all of the fat placed in the tank floats to the hasher and open kettle. Some of it sinks to the bottom and when the tank is empty attention is given to these "sinkers" to detect and condemn any that have become unfit.

*Steam Rendering Tanks.*—These are vertical cylinders constructed of heavy steel. They are like boilers in that they must withstand the high steam pressure that is built up in them during the rendering process and they are subject to considerable corrosion. The depth of the tank is usually a little more than twice the diameter. Steam is injected directly into the product in the tank until a pressure of at least 40 pounds is developed in the tank. The cooking of the material by direct contact with the steam distinguishes this method of rendering from all others. Before being used for rendering the tanks are thoroughly cleaned by washing them out. This is done generally with the use of a caustic solution. The tank is then filled about a third full of water and the fresh fats to be rendered are loaded in it up to within about 2 feet of the top.

If the operation of rendering has been carried on successfully, the contents of the tank will have separated into three layers of product: the tissue fiber and other débris in the bottom, tank water in the middle, and lard on top. When the loading has been properly done the line of demarkation between the lard and the tank water is approximately where the draw-off cocks are located. If for any reason this line of demarkation is above or below the draw-off cocks, the right levels can be attained either by the addition of water to the rendering tank or by the removal of tank water from it.

After the lard has been drawn off down to the level of the upper cock, water is gradually taken from the rendering tank and the line of demarka-

tion between the lard and tank water is brought slightly below the lower draw-off cock. If this operation is carried out carefully, nearly all of the lard can be removed from the rendering tank without contamination from the tank water.

The contents of the rendering tank remaining after removal of the lard are dropped into a tank placed immediately beneath. This material consists of a mixture of fiber and tank water with a small amount of rendered fat and partially cooked material. The mixture is heated to the boiling point and allowed to stand until the clear fat and partially cooked material have risen to the top of the tank. These are carefully skimmed and the rendered fat is separated from the partially cooked material.

During the rendering operation steam is vented from the top of the tank for the purpose of avoiding the development of an air pocket in the tank. This steam is not permitted to discharge into the rendering department but is vented into a pipe which directs it to the sewer.

*Dry Rendering.*—This is accomplished in a large, horizontal, steam jacketed tank equipped with agitators revolving on a horizontal shaft extending the length of the tank. Vapor lines connect these tanks with condensers which make it possible to conduct the rendering operation under a partial vacuum. This accomplishes two things, the principal one being to render the fat at comparatively low temperatures ranging from 180° to 200°F. and the other the rapid removal of moisture from the product. The rendering is completed when the moisture is completely expelled from the product and the rendered fat has been separated from the tissues.

The tank is thoroughly cleaned and attention is given particularly to the agitators to see that they are clean on all sides. The condensers are carefully maintained in operating condition for the efficient removal of the moisture from the tank, the maintenance of a vacuum in the tank, and the control of odors which are condensed along with the vapors and carried off to the sewer.

**Equipment for Handling Rendered Fat.**—The rendered fat as it leaves the tank requires settling to remove moisture and tissue particles which are drained off with it from the rendering tank. These settling tanks are equipped with heating coils to maintain the rendered fat in liquid condition so that the settling may be facilitated. The tanks receive regular attention to maintain them in a clean condition and cleanup is particularly thorough where the heating coils are located.

Storage tanks are also necessary to provide a reservoir between the rendering operation and the shipping of the rendered fats from the establishment. These tanks are also provided with heating coils, however, the fat is not maintained in a heated condition but it is necessary to melt the fat when it is pumped from the storage tank. The cleanup of the storage tank is quite similar to that of the settling tank.

The pipelines, pumps, and valves used to convey the rendered fat are demountable and maintained in a clean condition. The distribution system used for handling rendered fats in the establishment is under constant examination to detect any point along the line where the product might stagnate and spoil. An accumulation of spoiled rendered fat anywhere in the system can contaminate a large quantity of product.

Rendered fat tends to develop a grainy condition if allowed to set up without agitation. Equipment is provided, therefore, to avoid this when rendered fat is put up in cartons, buckets, and other containers for shipment to the trade. A chill roll is the device commonly used for this purpose. This consists of a large refrigerated cylinder that revolves slowly. The liquid rendered fat is picked up by the cold surface of the cylinder on one side of the piece of equipment and the chilled, solidified fat is scraped off the cylinder into a hopper on the other side of the roll. There is an agitator in this hopper and the solidified fat is picked up at one end of it and conveyed to the filling machine. Care is exercised in the location of a chill roll to make certain that it is protected against dust and moisture. A large surface of edible rendered fat is exposed on the chill roll and it would readily pick up any particles or moisture from the surrounding air.

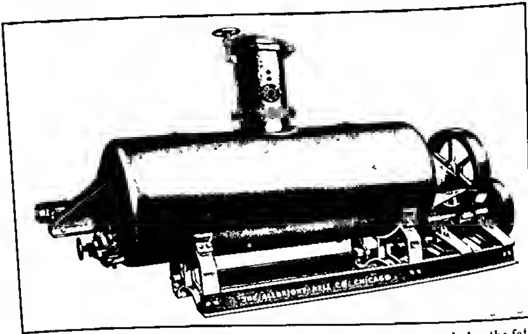

FIG. 81.—So-called "dry rendering tank" in which the heat used for rendering the fats is applied by a steam jacket.

*Refining.*—The refining of edible rendered animal fats consists principally of treatment with alkalies, mixing the fats with filter aids, and filtering out the filter aids. The equipment consists of tanks and filters. The tanks are large and open top. They may be equipped with coils for heating the rendered fat and with agitators for stirring it. The cleanup of these tanks and their auxiliary equipment is accomplished the same as with other fat handling tanks in the rendering department. The filter presses used to filter the rendered fat sometimes consist of a series of plates and use many layers of cotton duck material called filter cloths. It is necessary to dismantle these filter presses regularly to clean the plates and replace the filter cloths.

**The Residue Resulting from Rendering.**—The tissue remaining after drawing off the rendered fat in the various rendering processes contains a

substantial amount of fat. In the case of the residue from wet rendering, there is also present a large amount of moisture.

The residue from the wet rendering, after being heated and allowed to settle for the purpose of drawing off the rendered fat that rises to the top, is conveyed directly to the inedible rendering department where it is retorted along with inedible materials to reclaim as inedible rendered fat any of its fat content.

The residue resulting from the dry rendering processes contains a considerable amount of rendered fat. This is extracted by pressing either in a hydraulic press, a screw press, or an expeller. The hydraulic and screw press are of rather simple construction and are readily cleaned, however, it is necessary to dismantle the expeller as part of its cleanup.

**Curing Department.**—The air in curing departments tends to become saturated with moisture and as a result the walls, ceilings, and floors are at times quite damp. Regular and thorough cleanup in this department is necessary to control the growth of mold and prevent the production of a slimy condition on the surfaces of the wall and ceiling. These surfaces are, therefore, of impervious material as well as the floors which are pitched to drains so located as to facilitate cleanup and prevent accumulation of floor liquids.

Curing is conducted under refrigeration usually at about 38°F. This is necessary to prevent spoilage of the meat while it is undergoing the process of curing. In any case, the action of the curing materials on the meat only gives it a relative stability, and it is necessary not only to cure meat under refrigeration but also to hold the cured meat in a refrigerated condition during its storage incident to distribution to the trade.

Frozen fresh meats are frequently brought to the curing department, and it is necessary to defrost such meats before being subjected to the curing process. Space and equipment specifically provided for the defrosting of meats are necessary in order to avoid congestion of the curing department and assure that the defrosting will be done under sanitary conditions. Furthermore, the defrosting of the frozen meats is done under careful control to assure that certain of the meats will not completely lose their chill and enter into the first stages of decomposition. The defrosting of meats in warm rooms is dangerous in this connection since part of the meat will tend to lose its chill while the remainder is still frozen.

The defrosting of meat is accomplished either by spreading it on racks or by placing it in tepid water. During the defrosting of meat, juices tend to separate from it. The meat, therefore, is so arranged on racks that the juices will not drip from one piece of meat to the other and the racks are located over a drained area so that the juices will pass directly into the sewer and cleanup of the area will be facilitated. When the defrosting of the meats is conducted in warm water, the water is usually agitated to facilitate the defrosting. This water takes up the meat juices as the meat thaws out and it is necessary, therefore, to change the water at regular intervals so as to maintain clean conditions during the defrosting operation.

**Curing Materials.**—Salt is inspected for cleanliness when it arrives at the establishment. It is examined for indication that it had been handled under clean conditions prior to its arrival at the meat packing plant. The

presence of lint, vegetable matter, soil, and the like justify its rejection for use as a curing material for meat. Care is exercised to see that the salt is handled under clean conditions after it is received at the establishment. If the salt is dumped directly into the vat where it is to be dissolved in water for pickle manufacture, the opening into the vat is so constructed as to guard against the entrance of any contaminant through this opening. In some cases the salt is stored in bins from which it is taken to be used for several purposes in the plant. Such bins are so constructed that the salt can be dumped from the bin through a hopper directly into the hand trucks or other equipment for transporting the salt about the establishment. It is difficult to avoid the contamination of the salt when a storage bin is so arranged as to require a workman to enter it for the purpose of shoveling out the salt.

The nitrates, nitrites, and sugar are handled in containers that protect the contents from soilage and they are stored under clean conditions in the plant. The nitrates and nitrites are potentially harmful materials and care is exercised to assure against the accidental inclusion of excessive amounts of these materials in meat products. It is usually necessary for them to be kept under lock and made the responsibility of a particular plant employee.

**Pickle Manufacture.**—This consists of putting the salt in solution and clarifying the solution by settling and filtering. The vat in which the water is injected into the salt serves also as the first settling vat. That being the case, it is necessary to clean it out at regular intervals. The filtering device is one that is readily demountable and the filtering materials are such as to permit ready and thorough cleaning. In this connection filtering cloths are preferred to sponges as the latter do not lend themselves to thorough cleaning.

The settling and filtering of the salt solution incident to the preparation of pickle have for their purpose the removal of insoluble materials that may be present in the salt. This method of handling, however, does not justify the use of unclean salt in pickle manufacture.

Pickle that had been used for curing meats is sometimes reclaimed and used again. The curing pickle left after meats have been removed from the cure still retains a considerable proportion of the curing ingredients which can be used again. This reclamation requires very careful handling if the pickle is to be used with safety in subsequent curing.

The usual system is to boil the used pickle, settle it overnight, skim the surface, remove the settlings, then filter and immediately chill it to a temperature of 26° to 28°F. At the same time it is raised to 100° Salometer by the addition of salt. The equipment used for reclaiming pickle is thoroughly cleaned between each batch.

**Pumping Equipment.**—Large cuts of meats, such as hams, shoulders, and beef briskets, are injected with pickle into their interior. This is done by forcing pickle into them through a large hollow needle which is inserted deep into the meat and particularly to points along the bones of hams and shoulders. It is important that this pickle be free from contaminant because otherwise each injection of pickle into the meat would amount to an innoculation of the meat with dangerous organisms. Accordingly, the

container holding the pumping pickle, the line from this container to the pump, the pump whether manual or mechanical, the line leading away from the pump, and the needle are maintained in scrupulously clean condition.

**Curing Equipment.**—This refers to the tierces, hogsheads, vats, and boxes in which the meat is placed with the pickle. It is preferred that these containers be movable and of a size that can be readily handled. This permits them to be taken from the curing department to the equipment cleaning area to be cleaned following the completion of the cure of each batch of meat. Attempts to clean equipment in the curing department create unsatisfactory conditions there.

Curing equipment is never connected directly with the sewer. This avoids their interior becoming contaminated should there be any backing up in the sewer lines due to stoppage. Also there should be no continuity between the interior of meat handling equipment and the drainage lines.

Curing equipment is made of wood, galvanized metal, and stainless steel. Stainless steel curing equipment is most easily cleaned and maintained in a sanitary condition. Wooden equipment can be maintained in a clean condition so long as it is in good repair.

Wooden curing vats require reconditioning from time to time. They are taken to the cooper shop where they are washed thoroughly and permitted to dry out before commencing the reconditioning process. The inner surface of the vat is first gone over by a heavy duty flexible disc sander with a 5 inch bevel gouging planer head. This is to remove slivers, blisters, badly discolored wood and ridges from the inner surface of the vat. This surface is again gone over with a 9-inch open coat fiber combination oxide disc which accomplishes a smooth, clean surface. The outer surface of the vat is sanded to remove loose slivers from the staves and corrosion from the hoops. Badly rusted hoops are replaced with new galvanized ones. The vat is then flushed with clean water and steamed to remove particles of wood and dust and it is ready for use.

Galvanized metal is very extensively used, principally for curing bacon in what are called "bacon boxes." Galvanized metal tends to corrode and form a surface of white crusts in the presence of pickle. This can be controlled through a method of cleaning and surface protection that maintains these bacon boxes in a satisfactory sanitary condition. The galvanized metal box is dipped in a series of two vats, the first containing a hot solution of an alkali detergent such as sodium carbonate, sodium metasilicate and sodium hydroxide at 150°F. and the second a solution of an acid cleaner such as sodium bisulfate or monosodium sulfate at 130°F. The box is rinsed thoroughly before being placed in the first solution so as to keep the solution as clean as possible. The box is permitted to soak for twenty minutes in the first solution after which it is removed and placed in the second solution. It remains in the second solution from twenty to thirty minutes, depending on the degree of corrosion on the box.

When the corrosion becomes softened, the box is hoisted from the solution and immediately brushed with a metal sponge. The corrosion is easily removed if the box is brushed while it is warm and wet. After the corrosion is completely removed the box is thoroughly rinsed and it is heated by plac-

ing it over a steam jet. The purpose of heating the box after rinsing is to facilitate its drying before the protective coating of paraffin wax is applied. As soon as it is dry and while still warm the box is coated on all surfaces with a hot paraffin wax preparation. The coating consists of a mixture of 1 part paraffin wax and 1 part paraffin oil. This coating should be applied so as to constitute a very thin covering for the surface of the metal. A thick application tends to break and flake off and the particles may contaminate the product.

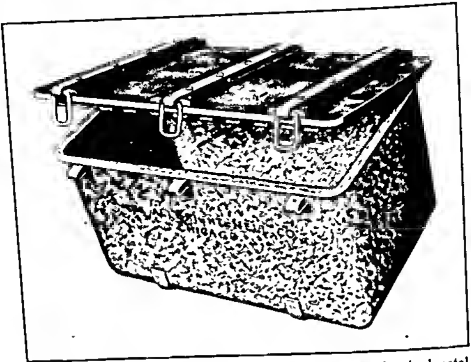

Fig. 82.—So-called "bacon box," made of heavy seamless galvanized metal.

**Dry Salt Meats.**—Not all meats are cured by immersing them in pickle. Some are cured by rubbing them on all sides with a mixture of salt with other curing ingredients. These meats are then stacked between layers of the curing mixture. Such meats are stacked on racks well above the floor so that the bottom of the stack will not be contaminated by floor liquids.

**Cured Meat Storage.**—After the meats have been cured it sometimes becomes necessary to accumulate stocks of cured meat incident to its distribution to the trade. They are stored at temperatures ranging from 26° to 38°F. depending on the length of time they are to be held which usually does not exceed thirty days at such temperatures. The cured meats are stored in bins that are demountable and hold the meat at least 1 foot above the floor. Following the removal of the meat the bin is dismantled and taken from the refrigerated department to the equipment cleaning area where the sections are thoroughly cleaned and aired before being returned to the refrigerated department.

**Smokehouses.**—The smokehouse and the approach to the smokehouse are constructed so that they can be readily cleaned. The approach to

the smokehouse, or as it is sometimes called, the "smokehouse alley," where tbe cured meats are hung before being placed in the smokehouse is drained to take care of the drip from the cured meats. This area is also vented so that the smoke as it escapes from the smokehouse when the doors are opened will pass to the outside rather than enter the meat processing departments adjacent to the smokehouse area. The walls and overhead construction of this area are of impervious material which will permit their being washed down as part of the cleaning operation.

The interior of the smokehouse is smooth and impervious. This is necessary to permit the walls being washed down with caustic solution to remove accumulations resulting from the smoking operation. The floor of the smokehouse is impervious and drained so that the wash water may pass directly into the sewer. When a smokehouse is more than one floor level high and it is entered from each floor level, care is exercised to see that the meat hanging in the lower level is not contaminated as a result of traffic in and out of the smokehouse at the higher level.

Sometimes steam is injected into the smokehouse to mingle with the smoke during the smoking process. When this is done the amount of steam is so adjusted that it will not result in condensation on overhead structures with resulting drip and contamination of the meats being smoked.

**Sausage Department.**—Owing to the large variety of meat food products prepared in what is usually called the sausage department and the various processes to which a large volume of meat is subjected in this department, careful attention is given to the layout of the department and flow of operations in it. The maintenance of standards of cleanliness is possible only if adequate equipment and space is provided for each processing operation.

The walls, floors, and ceilings are of impervious material that will permit thorough cleanup following each day's operation, and floor drains are provided. The equipment is of rust resisting metal construction so designed as to permit ready and thorough cleaning. Tools such as shovels, paddles, knives, and the like are of metal construction and have no crevices in which meat juices or meat particles accumulate and decompose. Containers, such as pans, tubs, and pails that are used for conveying meats, cereals, condiments, and the like, are placed off the floor on racks or trolleys. This method of handling so-called "tipping" containers avoids the contamination of the meat products with floor liquids that might otherwise be picked up by them and drain off into the food.

**Chopper.**—The plates and knives of chopping equipment are demountable to facilitate thorough cleanup following each day's operation. The knives are so constructed that there are no crevices in the plate in which they are set where meat particles and meat juices might gather and decompose. The knives in some classes of chopping equipment rotate at high speed. Precautions are taken to see that these knives are in good repair so that particles of metal from broken knives will not contaminate the food. Also, these knives rotating at high speed sometimes splinter when they hit hard particles such as a piece of bone. At such time the equipment is immediately stopped and the meat contaminated with metal splinters is eliminated.

Removable bushings and sleeves on reversible sausage-grinder plates tend to accumulate a considerable amount of meat fat and meat juices on the inner surfaces of the various demountable parts. As part of the regular clean-up operation, these parts are completely demounted and thoroughly cleaned.

The worm or feeder screw of most meat grinders is of cast metal. The center of this casting consists of a hollow core about 8 to 12 inches in length and 3 to 4 inches in diameter. This core is usually filled at the factory with

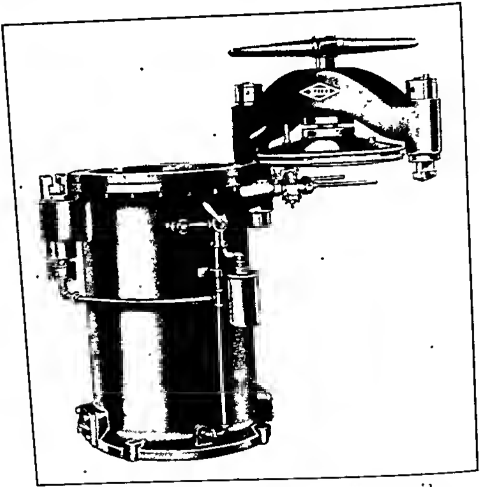

FIG. 83.—Sausage stuffer showing cover swung away to one side.

some impervious material. This filling is checked regularly to detect any crack, flaw, or faulty construction that would result in an accumulation of putrid material.

**Stuffer.**—The sausage stuffer consists of a cylinder with a removable top, and in the cylinder is a snug fitting piston which forces the meat through the stuffing horn. The top is removable and the horn and its valve are demountable. These are dismantled and cleaned thoroughly after each day's operation. There is a cleanout opening at the bottom of the cylinder. This opening which is covered by a tight fitting plate permits in-

spection of the back side of the piston to detect any meat or meat juices that might have passed around between the piston and the wall of the cylinder. The cylinder is cleaned out regularly to eliminate any accumulation of meat particles or meat juices behind the piston head. To assure that the stuffer is maintained in a clean condition at all times, it is necessary occasionally to remove the piston from the cylinder as part of the cleanup.

A large metal table accompanies each sausage stuffer extending away from the stuffing horn. This table is used as a work surface for linking and tying off the stuffed sausage. Liquids accumulate in varying amounts on this table and it is therefore drained in such a way as to direct these liquids to the sewer by way of an interrupted connection. This drain is of such construction as to permit its being thoroughly cleaned as part of the daily cleanup.

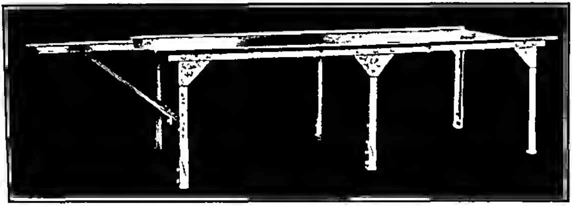

FIG. 84.—Sausage stuffing table.

**Spice Room.**—Spices and condiments are kept in a room adjacent to the sausage department. The room is reserved for this use and every precaution is taken to keep these materials in clean condition. The spices and condiments are stored in closed metal containers placed on racks at least 12 inches above the floor. The containers used for weighing and mixing the spices and condiments are also metal and of the kind that can be readily kept in a clean condition.

The spice room is not used as a general storage room since the handling of other materials in such a room creates an unsatisfactory surrounding in which to store and handle spices and condiments.

**Dry Storage.**—Supplies of many kinds are accumulated in the meat packing plant for use in connection with its meat production and packaging as well as for plant maintenance. Good housekeeping and cleanliness in storerooms are essential to a successful rodent control program. Since the supplies, for the most part, consist of materials used as ingredients of the meat foods prepared in the establishment or are packaging materials for such foods, the supplies are stored and handled under clean conditions so that they will not constitute a possible source of contamination for the meat foods.

So-called "dead" storage is avoided in the food processing plant because it is difficult to accomplish a progressive program of cleanup in an area

where there is such storage. Storerooms are provided for supplies that are currently needed as part of the daily operation. These supplies are placed on racks at least 12 inches from the floor and passageways are maintained between rows of racks. A systematic turnover of supplies is accomplished so as to avoid the accumulation of old and useless material. Also, as the supplies are removed from the storeroom the racks are taken up and cleaned and the immediate floor area is thoroughly cleaned before the racks are put back into place and used again lor supplies.

**Hide Cellar.**—There is complete separation of the hide cellar from all other departments in the meat packing plant. The only connection between it and the slaughtering department is the chute used for conveying the hides to the bide cellar. This chute is closed and vented at the slaughtering floor end. It is provided with a trap door which permits the hides to enter the chute and then closes automatically. The vent exhausts to the open air any odors which might pass up the chute from the hide cellar.

The walls, floor, and ceiling of the hide cellar are smooth and impervious so that cleanup may be facilitated. The floor is pitched away from the areas where the hides are stacked for curing, and floor drains are provided in the aisles between the stacks so that the liquids that develop during the curing of the hides may pass directly to the sewer.

Facilities are provided so that the cured hides may be removed from the establishment without passing through departments or over loading docks where edible products are handled. The hide cellar is located, therelore, so that the cured hides may be moved directly lrom it to the exterior ol the building where they may be loaded on trucks or cars using loading facilities specially provided for the purpose. This loading area is paved and drained and provided with a cleanup hose outlet.

**Inedible Department.**—This department performs a very important function in a meat packing plant particularly when slaughtering is conducted. It disposes of the large volume of inedible materials of animal origin that are produced incident to slaughtering animals for human food. The disposal of this large volume of material much of which is very objectionable in character is accomplished on the premises without creating a nuisance only when the inedible department is properly equipped and maintained.

This departmeot is completely separated from all other departments of the meat packing plaot except those few openiogs into the edihle products department that are necessary to convey the inedible materials from the other parts of the plant. The shipping dock serving the inedible products department is entirely separate from shipping facilities used for other purposes in the plaot.

The walls, ceilings, and floors are made of impervious material throughout this department and are of smooth finish to permit thorough cleaning. The floors are pitched to drains so located as to control floor liquids and facilitate cleanup. Cleanup hoses are conveniently located throughout the department.

Wherever possible chutes are used to convey the inedible materials through their various steps of baodling to the ioedible rendering tanks and in those cases where chutes cannot be used, the material is conveyed

by hand trucks of metal construction that can be readily cleaned following each day's operation.

The principal handling that the inedible materials receive in the inedible products department preparatory to tanking has for its purpose the removal from it of the contents from the digestive tract and to hash it to facilitate rendering. The inedible material is passed through hashers that reduce it to a shredded mass which is discharged into large revolving perforated cylinders where a spray of water washes out most of the contents of the

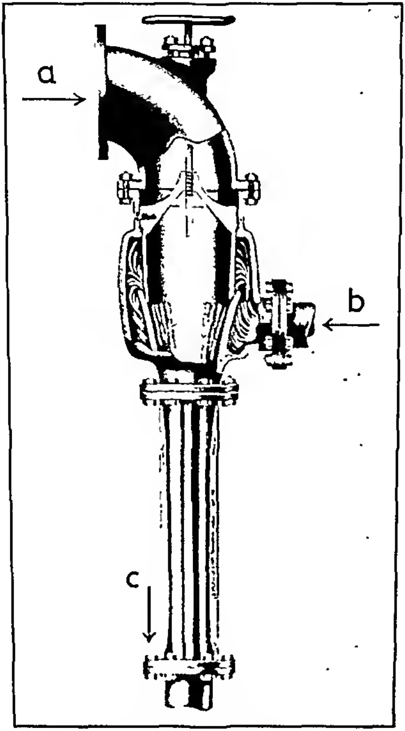


FIG. 81.—Odor condenser: *a*, Hot odor laden vapors enter condenser; *b*, cold water line; *c*, water and condensed vapors pass to sewer.

digestive tract. The hasher and washer are enclosed in a curbed and drained area connected directly with the sewer.

**Odor Control.**—Objectionable odors are produced in the inedible department in connection with the handling of the inedible material preparatory to rendering, and they are discharged along with the vapors from the rendering tanks. Closed vapor lines from the rendering tanks are connected with condensers. In these condensers the hot vapors from the rendering tanks are showered with cold water. This cold water condenses the vapor and at the same time dissolves many of the offensive gases and carries them to the sewer. The offensive gases in the vapor lines that are not dissolved in the condenser water are vented to a chamber where they are in some cases chemically treated while in others directed to the boiler stack where they are either burned or discharged to the atmosphere high in the air. The rooms throughout the inedible products department are also vented to the chamber that receives the undissolved offensive gases from the vapor lines. The room odors are controlled in the same way either by chemical treatment or they are discharged into the boiler stack.

Inedible rendered fat and tankage are produced in large quantities in the inedible rendering department. Accordingly, adequate facilities are provided for their storage and shipment from the plant. The pipe lines used to convey the inedible rendered fats are marked distinctively to avoid their being confused with pipe lines used to convey edible rendered fat.

# Chapter 8

# FACILITIES FOR INSPECTION

THE observance at a meat packing or a poultry packing plant of the principles of meat hygiene depends to a large extent on the effectiveness of the inspection supervision given such a plant. The personality and training of each inspector are factors that are influenced by the training program of the particular inspection organization. However, the inspector who is capable and properly trained functions effectively only if he is provided with adequate facilities for the conduct of his inspection.

In this chapter, the facilities for inspection provided by a meat packing plant are covered in some detail. The subject matter applies equally to the poultry plant. Differences in detail between a meat packing plant and a poultry packing plant will be obvious and require no special mention. In any case whether a problem involves a particular meat packing plant or a particular poultry packing plant, the descriptions of facilities contained in this paragraph can at best serve only as guides to meet effectively a specific situation.

The inspector is provided with dressing room and office facilities in the meat packing plant apart from similar facilities used by plant employees. This arrangement permits the inspection organization to maintain its identity as a functioning entity in the plant.

Each operation in the plant that is concerned with the processing and handling of the meat as human food is planned and conducted so as to give the inspector an opportunity to inspect. For example, no slaughtering is conducted and no meat is prepared except during the hours when the inspector is present. When the meat packing plant is laid out and equipped, appropriate space and equipment are provided at those points where inspection is required. Furthermore, the management of the packing plant provides the inspector with such assistance as is necessary to facilitate his inspection.

The general cleanliness in the packing plant, or what is sometimes referred to as environmental sanitation, is controlled by the inspector through his ability to require clean conditions surrounding the handling and preparation of the meat for human food. He accomplishes this by prohibiting the preparation of meat in an unclean environment or under unclean conditions. This prohibition is enforced by the inspector through the exercise of his power to reject an unclean department or unclean equipment. This rejection is enforced by using a reject notice which is posted in the department or affixed to a piece of unclean equipment. The reject notice carries a warning that the department or equipment so identified shall not be used

until it has been placed in a clean condition and released for use again by the inspector.

The inspection supervision extends to all steps in the production of meat and its products in the packing plant from the time the animal or bird is

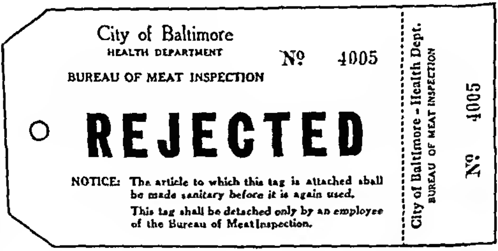


FIG. 86.—Tag used by inspectors of the Health Department of the City of Baltimore to prohibit the use of any unclean article in connection with food.

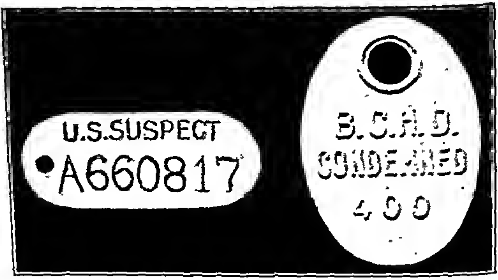


FIG. 87.—*a*, Metal tag used by Federal meat inspectors to identify animals that are "suspected" on ante-mortem examination; *b*, metal tag used by meat inspectors of the City of Baltimore to identify animals that are condemned on ante-mortem examination.

presented for slaughter to the shipment of the meat food product to the trade Facilities for performing the inspection are provided for each step.

**Ante-Mortem Inspection.**—The animals intended to be slaughtered at the meat packing plant are placed in pens sufficiently large to permit the inspector who conducts the ante-mortem inspection to move among the

animals for the purpose of observing them to detect any abnormal condition. The pens are well lighted so that the inspector is able to detect deviations from normal in the animals that he observes. He is given an assistant who is furnished by the plant for the purpose of moving the animals about as the inspector might require and to separate out the animals that are suspected of being affected with an abnormal condition.

The inspector is furnished with ear tags for use in identifying the animals which he does not pass for slaughter. These animals are separated from the other animals and removed to a holding pen where they can be given a more

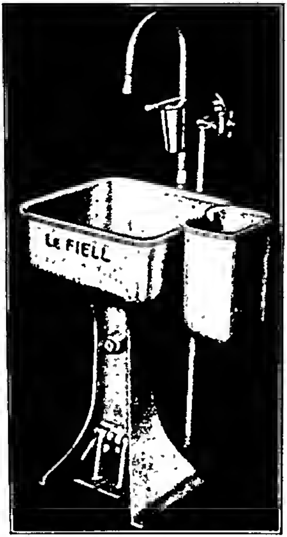


FIG. 88.—Lavatory with cast aluminum knife sterilizer and drinking fountain attachment. (Le Fiell Mfg. Co., Los Angeles).

thorough physical examination. This holding pen is provided with facilities for restraining the animal should it be necessary for the examination. If the animal is found to be affected by a condition that requires its condemnation, it is identified with an ear tag reading "Condemned" and facilities are provided for removing it directly to the inedible rendering department for disposal without entering an edible products department. The animal suspected of being affected with a condition which might influence the disposition of its carcass on post-mortem examination is marked with an ear tag reading "Suspect" and facilities are provided for removing animals

so identified to the slaughtering department separate from the animals that are passed without restrictinn.

**Post-Mortem Inspection.**—The steps in the slaughtering operation differ somewhat for each species. However, with the exception of inspections conducted on the carcasses of sheep and goats which do not include the examination of the cervical lympb glands, there are three routine post-mortem inspection locations and one location for the inspection of retained carcasses in each slaugbtering layout. The routine inspection locations are first, the place where tbe head and cervical glands are inspected, second, the viscera inspection position, and, third, the place where the eviscerated carcass is examined before it leaves the slaughtering department.

At each inspection location there are nne or more units consisting of a lavatory and a sterilizer. The water outlet delivering tempered water is located 12 inches above tbe rim of the bowl of the lavatory and a liquid soap dispenser is provided. The water is either allowed to flow constantly into the lavatory or there is a foot pedal operated valve. The sterilizer which contains boiling water is used to disinfect disease contaminated equipment, such as the knives used by inspectors. The water is kept boiling in the sterilizer by injecting live steam into it.

Section tags bearing identification numbers are affixed to heads and corresponding carcasses when the bead is separated from the carcass, such as occurs during the dressing of beef carcasses. This permits assembling for final inspection both parts of the same carcass wben a disease condition is found in either one.

The inspector uses tags and brands to maintain the identity of diseased and condemned carcasses and parts. When a diseased or otherwise abnormal condition is found by the inspector, he affixes a "Retained" tag to the various parts of the carcass and its viscera. The retained tag comes in gangs of three for use on small stock and five for use on cattle. In addition to the word "Retained" tbey are printed witb a serial number which is identical on each gang of tags. When a condition is found whicb requires condemnation of a carcass or any part thereof, tbe word "Condemned" is branded in prominent letters on the carcass. The hrand is applied repeatedly to carcasses and large sets of viscera so that the word "Condemned" is prominently displayed. The words "Retained" on the tags and "Condemned" on the brand are accompanied with an identification of the agency having jurisdiction, as for exampfe, "U. S. Retained" and "U. S. Condemned."

The inspectional and sanitary control by an inspector in a slaughtering department is completed hy his power to limit the speed of slaugbter to his ability to inspect. Since tbe rate of the slaugbtering operations in departments that have a substantial volume is determined by the speed of the chain on which the carcasses travel, the inspector is furnished with a push button or otber device for limiting the speed of this cbain. This enables the inspector to meet situations which sometimes arise in connection witb an unusually high incidence of diseased carcasses or an insanitary condition. For example, it is sometimes necessary to stop the chain to enforce the requirement for clean hog carcasses.

The equipment used for the inspection of cattle and calf heads and their

cervical glands is similar. Where there is a small volume of slaughter, the heads, after they have been removed from the carcass and cleaned thoroughly, are placed individually on loops which present the ventral and posterior surfaces of the head for the inspection. These loops are removable so that they can be taken from the rack or truck for cleaning as each head is removed. The inspection of the head is completed while it is on the loop and it is not removed from the loop until after the carcass from which the head was taken has passed the inspection. This necessitates furnishing a

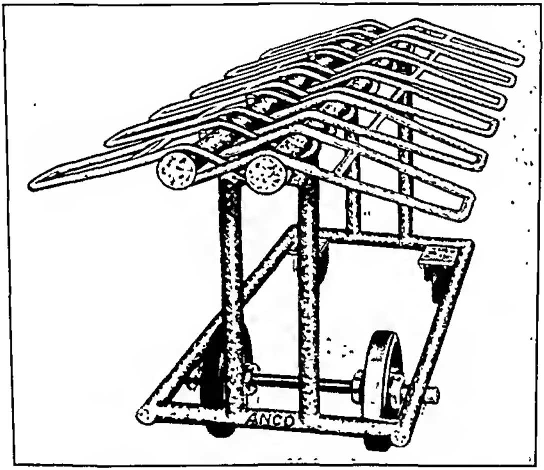


FIG. 89.—Loops on which cattle heads are placed for inspection.

sufficient number of the loops to accommodate heads from all of the carcasses that are in the process of handling in the slaughtering department beginning from the time the head is removed until the time that the carcass passes the rail inspection.

In slaughtering departments that have a large production capacity, there is furnished a moving chain provided with hooks on which the heads are placed for the inspection. The hooks on such a chain are spaced 21 inches apart so that the heads as they are suspended from the hooks will not contact each other. The point of the hook is 54 inches above the standing level of the inspector. The chain passes through a cabinet which cleans and disinfects the hooks to avoid the probability of carrying contamination from a diseased head to one that is passed for food. The length of the chain is determined by the number of hooks that are necessary to accommodate the heads from all of the carcasses in the process of dressing.

Depending on the rate of slaughter, the heads of hogs are either inspected while still attached to the carcass or they are removed from the carcass and presented for inspection along with the viscera. The heads are inspected while attached to the carcasses when slaughtering operations of considerable volume are involved.

In those cases where the hog head is inspected while attached to the carcass it is severed from the cervical vertebræ at the pole and it is dropped by cutting transversely permitting it to hang attached to the carcass by leaving a portion of the ventral surface of the neck intact. This presents

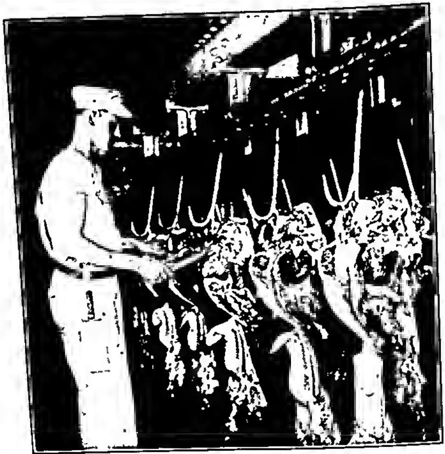

Fig. 90.—Cattle heads being inspected while suspended on hooks from a moving chain.

the postpharyngeal region for inspection. It is important that the position of the head and its height above the level where the inspector stands is such that it is convenient and readily accessible for the inspector. When the hog head is presented with the hog viscera for inspection, both the head and the viscera of the same animal are presented together for inspection. The head is placed in a pan equipped with a loop for steadying it in position for inspection. This pan is 1 foot wide and 30 inches long. It is made of rust-resistant metal and is readily removable from the stand on which it is placed. The pan is cleaned before receiving each head, and should it become contaminated, facilities are provided for submerging it

FIG. 91.—Hog heads being inspected while attached to the carcass.

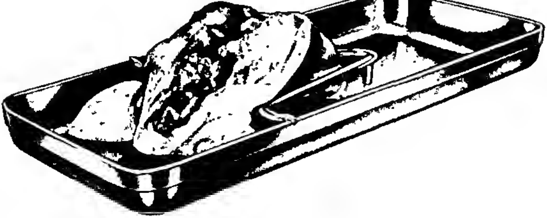

FIG. 92.—Pan showing hog head in position for inspection.

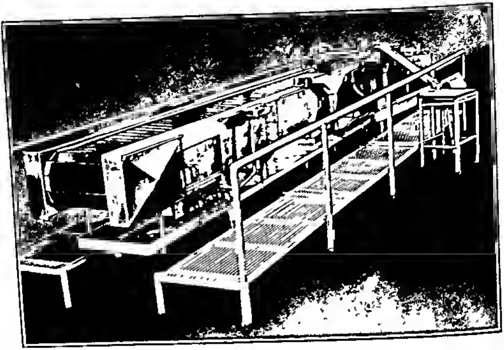

FIG. 93.—Poultry viscera table.

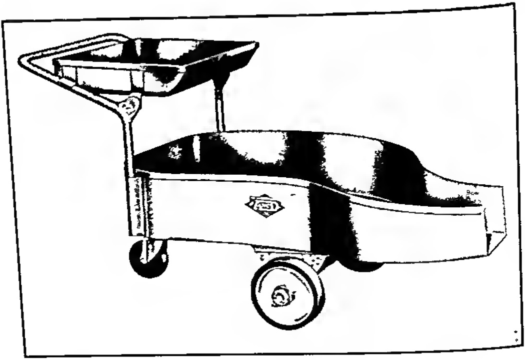

FIG. 94.—Cattle viscera inspection truck. (Albright-Nell Company, Chicago).

after cleaning in boiling water. This arrangement for placing the head in a pan for inspection at the same time inspection is conducted of the viscera is also used in connection with small scale calf slaughtering operations.

**Viscera Inspection.**—The viscera of cattle are presented for inspection either in a hand truck specially designed for the purpose or on a moving table. The viscera truck is used in cattle slaughtering departments having a low rate of slaughter. This truck has a large low-slung body approximately 1 foot deep to accommodate the stomachs and intestines, and there is a pan approximately 26×26×3 inches in which the lungs, heart,

FIG. 95.—Inspection being conducted of hog viscera on a "moving top" table

spleen, and liver are presented for inspection. This pan is to the rear of and elevated above the main body at a height of 30 inches from the floor.

The area in the vicinity of the carcass where evisceration is conducted is sufficiently spacious to accommodate the viscera inspection truck and permit free movement of the inspector to enable him to perform his inspection duties. Off to one side of the slaughtering beds there is located an area at least 7×8 feet that is drained and enclosed on three sides. The viscera inspection trucks are brought to this area for cleaning and disinfecting following the handling of each set of viscera. In this area are hose outlets of tempered water for cleaning and water of 180°F. for disinfecting.

When a moving table is used for presenting cattle viscera for inspection the carcass passes over the table and the viscera is dropped directly on the table. As the viscera moves with the table to the inspection position, the

eviscerated carcasses swerve away from the table so that the inspectors can be located on both sides of it to perform the inspection.

It is arranged that all of the viscera that is passed for inspection is removed manually from the table before it reaches the end of the table. Only condemned materials are permitted to drop off the end of the table. They usually drop into a chute which conveys them directly to the inedible products department. The height of the table above the level where the

FIG. 96 — Inspector examines fowl as it passes him on the dressing line. (USDA photo)

substantial volume. Another kind of moving table is used for the inspection of hog viscera in slaughtering departments of medium volume consisting of a series of two paus, one 24 × 30 inches for the viscera, the other 12 × 30 inches for the head.

In both cases the height of the table above the standing positiou of the inspector is 34 inches. Here again a specified space is reserved along the table for use exclusively by the inspector.

Stationary viscera inspection equipment is used iu hog slaughtering departments of small volume. This consists of two pans on a metal frame, the pans being placed over a drained hopper counected with the sewer. One of these pans 24 × 30 inches accommodates the viscera, while the other which is 12 × 30 inches is used for presenting the hog head for inspection. The same equipment is frequently used for inspecting the viscera of calves and sheep. Then the thoracic viscera and the liver and spleen are placed in the small pan and the stomachs and intestines are placed in the large pan. The same two-pan arrangement is used on a moving table for calves and sheep slaughtered in substantial volume.

**Inspection of the Carcass.**—The inspection of the carcass after evisceration is commonly called the rail inspection. Each carcass is examined by the inspector as it hangs from the rail. For the inspection of a beef carcass, the standing position of the inspector is 9 feet 6 inches from the top of the rail. For the rail inspection of a hog carcass, the standing position of the inspector is 8 feet 6 inches from the top of the rail. The distance from the gambrel to the standing position of the inspector for the rail inspection of sheep and calf carcasses is 7 feet 6 inches. Cattle carcasses are hung from the dressing rail on 8 foot centers. Three foot centers are provided on the dressing rail for calves and sheep. Three foot centers are also provided on the dressing rail for hogs when the two-pan arrangement is used on the moving viscera inspection table to present the heads as well as the viscera for inspection. When the hog head is inspected as it hangs from its carcass, 2 foot centers are adequate for the hog carcasses on the dressing rail.

**Final Inspection.**—This refers to the inspection given to carcasses and their viscera which are found on routine post-mortem inspection to have been infected with some diseased or other abnormal condition that requires them to be given a more thorough examination to determine whether they are suitable for human food. This inspection is conducted in a space specifically set apart for the purpose. Its size is determined by the volume and kind of slaughtering operation. It is located conveniently to the flow of carcasses in the dressing operation so that the carcass and its viscera, which are retained during routine post-mortem inspection on account of some diseased or abnormal condition, may be removed from the flow of the dressing operation for final inspection conveniently and without any danger of contamination of other carcasses or viscera.

The space in which the final inspection is conducted is equipped with head loops and viscera pans for holding these parts for inspection in connection with the final examination of the carcass. This area is drained and enclosed in such a way that cleanup and disinfection of the floor and contaminated equipment can be accomplished without endangering products in *surrounding areas. In connection with slaughtering departments*

of large production with the handling of a large quantity of condemned carcasses and parts of carcasses in the space where the final inspection is conducted, chutes are provided for conveying the condemned material directly from this space to the inedible products department.

**Inspection of the Manufacture of Meat Products.**—Diseased and otherwise unfit meat and meat by-products are eliminated from the public food supply in the slaughtering department. Clean, fresh meats and meat by-products come to the manufacturing departments in the packing plant and the inspection activities in these departments are concerned with seeing that nothing in the handling of the meat or in what is added to the meat during the process of manufacture makes it unclean or otherwise unfit for food. The facilities required for an inspection control that will accomplish this contemplates the handling of the meat in a clean environment with clean equipment, that no unfit or harmful ingredients are added to the meat, that it has been properly prepared, and that it is not mislabeled.

The inspector has an opportunity to examine into the cleanliness of the department and the equipment before meat is brought in for handling and processing. He has an opportunity to examine the containers in which the meat is placed to determine whether they are clean and whether they are so constructed that they will not contaminate the food. He examines materials that are intended to be used as ingredients of the meat food, eliminating those which are harmful, unclean, or otherwise unfit. He is provided with facilities to reject for use any department, equipment, or ingredient that is unsuitable.

The inspector is informed concerning the methods used in processing the meat foods, and such devices as dial thermometers which register the temperatures attained during the processing are provided so that the inspector can check the adequacy of the processing. The facilities provided for the inspector, so that he might properly supervise the methods used in the processing of the meat foods, have for their purpose such determinations as trichinæ control and safety of canned product. Also, the inspection supervision ascertains whether a product has actually been prepared in accordance with representations made in connection with its sale, as, for example, a product labeled with the word "roasted" is required to have actually been roasted.

The inspection control which has for its purpose the production of canned meats that are safe for distribution to the trade is concerned with the adequacy of the heat processing of the canned article. This is accomplished in two ways. Each batch of canned product as it comes from the closing machine is identified with a tag which changes color as it passes through the retort. The inspector can tell at a glance by the color of the tag affixed to each batch of canned product whether, in fact, a particular batch had been processed in the retort. The second test consists of incubating representative samples from each batch after the heat processing in the retort. A room held at approximately 100°F. is equipped with shelves for holding the samples of canned product and a recording thermometer that maintains a record of the room temperature. Each can of product is identified by code as to its contents and the date of processing. In this way the sample given the incubation test is identified with a particular

batch of product which can be retained for reinspection should the sample not pass the incubation test.

**Labeling.**—Inspectional control over the composition of a product and the method used in its preparation as they relate to consumer expectancy is best exercised through the ability of the inspector to accept or reject the label intended to be used on a particular product. Since the opportunity to review a label after the product is prepared and ready for labeling would afford a minimum of opportunity for taking corrective action, prior inspectional review of labels is made. The management of the packing plant

FIG. 97.—Sample cans of lots of canned meats being examined after incubation.

presents the label to the inspector for his review with information concerning the product on which it is to be used. If the inspector rejects the label, the plant management is informed concerning the appropriate corrective action necessary to obtain acceptance for the label and correction is accomplished before the label is used on the product.

**Control of Condemned Product.**—The elimination of diseased or otherwise unfit meat and meat products by the inspector is effective only if such product, when condemned by him, is in fact destroyed for food purposes. The facilities for handling the condemned product incident to its destruction are therefore of utmost importance. The equipment used for handling and transporting condemned product is used exclusively for that purpose and is of watertight construction to avoid contamination of the premises or other products with diseased material.

The condemned product is kept constantly under inspection supervision from the time it is detected by the inspector until it is destroyed for human food. This is accomplished by a combination of personal supervision by the inspector and constructive supervision through the use of sealed containers, trucks, chutes, and compartments. These are equipped so that the seal cannot be tampered with or removed without detection by the inspector, and are of tight construction such as would make impossible the diversion of the condemned product.

# Chapter 9

# MATERIALS ADDED TO MEATS

Foods prepared from meat and with the use of meat ingredients are many and varied. In their preparation is used a large variety of materials that influence the flavor and character of the finished product. These materials, like the meat with which they are used, are proper ingredients of the meat food product only if they are clean, free from adulteration, and harmless. Some understanding on the part of the inspector of the origin and character of these materials gives him a proper background for making determinations concerning their acceptability for use at the packing plant. This chapter, therefore, considers briefly some of the materials most commonly used packing plants in the preparation of meat food products and poultry products.

**Salt.**—Common salt exists in nature either in a solid state or in solution. It is universally distributed over the earth and is the most abundant of the native soluble salts. In the solid state, it is called rock salt, halite, fossil salt, or sal gemmæ and is often found forming extensive beds and even entire mountains from which it is taken in blocks or masses by mining operations. The geological position of rock salt is very constant, occurring almost invariably in secondary formations associated with clay and gypsum.

The principal salt mines are found in Poland, Hungary, and Russia; in various parts of Germany and Austria, particularly the Tyrol; in Cheshire, England; in Spain; in various parts of Asia and Africa; in Turk's Island near St. Domingo; and in Peru and other countries of South America. There are a few mines in the United States located in Louisiana, Kansas, and in the western part of the State of New York.

Salt in solution exists in certain springs and lakes and in the water of the ocean. There are numerous salt springs in the United States which either flow naturally or are produced artificially by sinking wells to various depths in places where salt is known to exist. These are found principally in Missouri, Kentucky, Illinois, Ohio, Michigan, Pennsylvania, Virginia, West Virginia, and New York. Much commercial salt is obtained from the water of the Great Salt Lake in Utah which contains nearly 25 per cent of salt.

The salt is obtained from these various sources by crystallization from solutions which have been concentrated by evaporation using either solar or other source of heat for the purpose. Equipment used for crystallization varies from the retaining enclosures used for the concentration of water by solar evaporation to modern, triple-effect vacuum pans.

The size of the salt crystals is influenced by the evaporation temperature and by the presence of foreign materials. Sodium chloride usually crystal-

lizes in cubes but following quiet evaporation it often assumes the form of hollow quadrangular pyramids or hopper-shaped crystals consisting of an aggregation of cubes.

Pure sodium chloride is permanent in air but most of the commercial salt is more or less hygroscopic because of the presence of impurities. These include traces of insoluble matter and small amounts of calcium

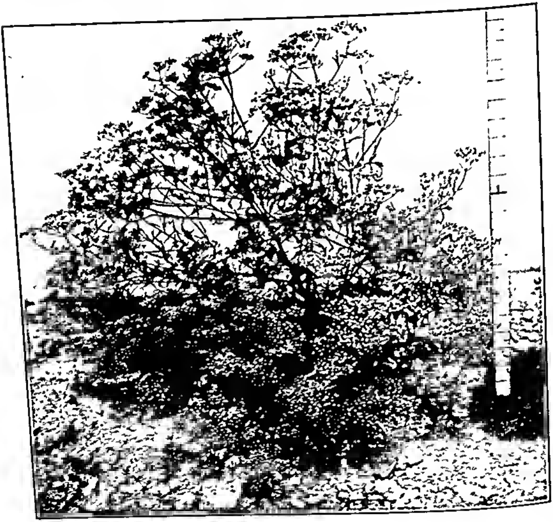

FIG. 98.—Anise.

and magnesium sulfates and calcium and magnesium chlorides. This kind of salt which is used for culinary and for industrial purposes is generally damp from the hygroscopic character of the calcium and magnesium chlorides present. To overcome this tendency to become damp there is added to some kinds of table salt a small amount of moisture absorbent materials. For this purpose calcium phosphate, magnesium carbonate, and starch have been used.

**Seasonings.—Spices.**—These are exclusively of vegetable origin and owe their flavoring quality to the presence of aromatic essential oils in their

cell structure. Unlike fatty oils, the essential oils volatilize at ordinary temperature. Only those spices are fit ingredients of food that are clean, free from débris and adulteration, and have not deteriorated in aromatic strength. Being of vegetable origin they may accumulate vegetable and soil débris in connection with their gathering and handling. Since they are rather expensive and are sold accordiug to weight, there is a temptation to increase their bulk by adding less expensive material. The essential

FIG. 99.—Basil.

oils, being volatile, tend to evaporate and the spices deteriorate in aromatic strength as their age increases. Spices also deteriorate through oxidation and resinification of their essential oils.

*Allspice.*—Allspice, also called pimento and jamaica pepper, is the dried unripe fruit of the pimento tree which belongs to the myrtle family. The fruit which appears soon after the blossoms is a smooth, glossy, succulent, globular berry from $\frac{2}{10}$ to $\frac{3}{10}$ of an inch in diameter, about the size of a small pea. The berry is not allowed to ripen fully because it then becomes black and tasteless, losing its aromatic property. During the harvesting care must be exercised to separate the inferior, ripe berries from the unripe ones. The allspice tree is found on most of the islands in the Carribean Sea and it is most abundant in Jamaica which produces the greater part of the commercial allspice.

*Anise.*—It is the seed of an annual herb of the carrot family that came originally from the Orient. It has an intensive sweet taste.

*Basil.*—This is an annual herb of the mint family called herb royale in France. It is reported as being a native of India and Africa but it is now cultivated widely as an aromatic plant for seasoning. The characteristic aromatic flavor is contained in the leaves of the basil plant.

*Paprika.*—This is one of the less pungent of the varieties of red pepper. The substance that gives red peppers their pungent properties is produced almost entirely in the thin paper-like tissues of the placentæ to which the seed is attached. Even in the mild paprika pepper this sometimes is somewhat pungent. The degree of pungency of ground paprika may, therefore, depend on the thoroughness with which the placentæ are removed. The removal of the seed and placentæ results in a mild product while grinding the whole fruit makes a product of more pungency. The so-called Spanish paprika is the mild type.

*Pepper.*—Both black and white pepper are products of the black pepper vine native to the forests of western and southern India and for centuries cultivated on the Malay Peninsula, Sumatra, Java, Ceylon, Siam, and Borneo. They are the only spices that grow on a climbing vine. Black pepper is the unripe, dried berry of the pepper vine. White pepper is produced from the ripe berry by removing the outer coat. This is accomplished by soaking the berry in water for several days and rubbing off the outer coat by friction. White pepper is also made from the dried black pepper berry by milling it to remove the outer coating. Since the greater strength of the pepper berry is found in the outer cover, the white pepper tends to be milder in flavor than the black pepper.

*Sage.*—This is a member of the mint family and is a shrub-like perennial cultivated in many countries of moderate climate. The leaves and the small tops of the sage plant contain the characteristic aromatic quality.

*Thyme.*—This is a small perennial shrub also of the mint family. Thyme is harvested when the plant is in bloom. The bloom and green parts of the plant are used and in the preparation of this spice the stems are eliminated. The lemon-scented is the best variety of thyme.

*Mustard.*—Commercial mustard seed is obtained from several closely related species and varieties of brassica which are annual plants of wide geographical distribution. The seeds of these varieties differ slightly in

size and range in color from pale yellow to black. The most important varieties are the yellow (sometimes referred to as white mustard), the brown, and the oriental types. There are three sources of commercial seed that is consumed in the United States, (1) seed produced in the United States under cultivation, (2) seed from wild plants obtained from grain screenings, and (3) imports. The yellow seed unground is frequently used in pickle, especially in sweet mixed pickles. Mustard leaves are sometimes used for garnishing. Mustard oil has a very sharp taste and acts upon the skin as a strong irritant.

*Nutmeg and Mace.*—These are produced by the same tree which is an evergreen. The fruit of the nutmeg tree is about 3 inches long and about 2 inches in diameter and occurs on the tree intermingled with flowers. The fruit hangs pendulous from the tree and is fleshy and firm, being pear-shaped when ripe. The outer covering of the fruit is at first thin and gradually grows fleshy. As this becomes dry it bursts open into two valves from the apex disclosing a brilliant scarlet aril or net-like membrane revealing the nutmeg kernel. The kernel is closely invested in a thin brown sbell which separates it from the aril or mass that envelops both. The nutmeg fruit includes, first, the outer or flesby membraneous part; second, the substance covering the inner shell of the nutmeg which is the mace; third, the inner shell, and, finally, the kernel or nutmeg.

The flavor of mace and nutmeg is somewhat similar but nevertbeless distinct. The flavor of mace is preferred by some people and it generally costs more than nutmeg.

*Turmeric.*—Turmeric is a large-leafed herb closely related to ginger aud of the same family. Its rhizome, or underground stem, like ginger, contains the characteristic aromatic flavor. This spice has a bright yellow color and a pleasaut, musty flavor. It tends to impart its color to the food in which it is used.

*Sweet Bay.*—This spice consists of the leaves of a small tree of the laurel family that is a native of the Mediterranean region. The tree is commonly used as an evergreen tub plant and is of the same family as cinnamon and sassafras. It is also cultivated in shrubberies and sheltered gardens in Europe. There is no relation between sweet bay and bay rum. Bayberry leaves impart to bay rum its characteristic flavor.

*Capers.*—They are the flower buds of the caper bush which is found in southern Europe and along the Mediterranean. The smallest, greenest buds have the finest flavor and they are gathered fresh in the morning before they have opened. Capers are pickled in white vinegar and salt. Buds of bean-caper and nasturtium are sometimes substituted for capers.

*Caraway.*—This spice consists of the seed of a biennial or annual herb of the carrot family. It is supposed to have originated in Caria in Asia-Minor from where it gets its name. Caraway seeds have a hot and acrid but pleasant taste. They are exported from Holland, Prussia, Morocco, and Russia. Caraway is usually sown with coriander. The coriander is harvested before the caraway produces a flowering stem. Young shoots of the caraway plant are used for flavoring soups and stews.

*Cardamon.*—This is the fruit of various East Indian or Chinese plants of the ginger family. All are natives of the tropical parts of India.

*Cassia.*—Cassia bark and cassia buds are derived from one or more species of trees of the laurel family. The buds are the dry, unripe fruit of the Chinese cassia tree. The bark and buds have a cinnamon flavor. The bark is considered to be less desirable than cinnamon and is used chiefly as a substitute for it.

*Cayenne.*—This and other pungent red peppers are obtained as dried fruits from an annual herbaceous plant widely cultivated in many parts of the world and variable in the character of its fruit. They are closely related to the so-called sweet or mild-flavored variety commonly grown in home gardens. The pungent varieties are used as dried peppers to distinguish them from the others used in fresh condition and classed as vegetables. Included among the dried peppers is the paprika, a mild type (see page 280).

The pungent red peppers as they appear in the trade vary in size, shape, and degree of color and pungency. The pungency is greatest in the tissues near the seed and the extent to which these tissues are used determines to some degree the pungency of the finished product. The varieties of pungent peppers are known under various names such as chili, cayenne, and tabasco.

*Celery seed.*—The celery plant is a biennial herb sometimes an annual and is widely grown in all temperate regions. The dried fruit commonly called seed is very aromatic and is extensively used for flavoring foods.

*Chives.*—These are bulbous, onion-like plants of the lily family. They are grown throughout Europe, Asia, and America. Chives have an odor and taste resembling onions and the leaves are frequently used instead of onions for flavoring.

*Cinnamon.*—The bark of the cinnamon tree which is an evergreen of the laurel family is the usual cinnamon distributed to the trade. The entire tree has an aromatic quality; however, the bark contains the typical flavor of cinnamon. The true cinnamon is a native of the Island of Ceylon where it appears to make its best growth. However, it also is grown in southern India, Burma, and the Malay Peninsula. The quality of the bark depends on its position on the branch. That from the middle is the best. The top is second best, and the third grade comes from the base or thicker part of the branch. The best bark comes from shoots two years old, particularly those grown in the shade.

Cinnamon bark has a pleasant odor and a slightly sweet taste. In addition to being used as a spice, it is also used in the maufacture of incense.

*Cloves.*—These are the dried, unopened flower buds of an evergreen tree belonging to the myrtle family, native of tropical and subtropical regions throughout the world. They get their name from the French "clou" meaning nail which they resemble somewhat. Cloves were one of the principal Oriental spices, being the basis of a rich trade since early times. The clove is very rich in essential oil containing a greater proportion than any other plant. Water extracts very little of the flavor of cloves. The essential oil combined with resinous material gives cloves their pungency and their aromatic property depends on the amount of oil they contain. The best cloves are large, plump, purplish-brown in color and unbroken.

*Coriander.*—The article known as coriander seed consists of the dried,

ripe fruit of a hardy annual herb of the carrot family. The ripening of the coriander fruit is progressive and this causes some difficulty in the harvesting of the crop which may start when approximately one-half of the total fruit formed has turned gray. The plant is indigenous to southern Europe, Asia Minor, and the southern part of Russia, and has been planted in most parts of the world where the climate is suitable. There has been no sustained commercial production in the United States.

The unripe fruit has a distinctly unpleasant odor characteristic of other parts of the plant. The ripe, dry fruit, however, has a pleasant aromatic taste.

*Cumin.*—This is the aromatic fruit of a small, slender, herbaceous annual of the caraway type cultivated in India and the Mediterranean region of Europe. It is known in the trade as cumin seed. It has not been produced commercially in the United States. The seeds have a peculiar strong aromatic odor and hot taste.

*Dill.*—This is the aromatic fruit (called seed) of a hardy annual or biennial herb of the carrot family. It is grown as a commercial crop in the North Central States of the United States, however, it is a native of southern Europe. Probably its most extensive use in foods is in the pickle industry. The best quality seed is that which has fully matured but has not turned brown in the field.

*Garlic.*—This is a bulbous, onion-like member of the lily family and is a native of southern Europe. Garlic belongs to the same genus as chives, leek, onions, shallot, and the Welsh onion. The bulbs and leaves are both used as seasoning. The whole plant has a peculiar taste and smell which is taken up by the breath and perspiration of the consumer. The strong flavor is due to an oil that is rich in sulphur.

*Ginger.*—This is a biennial or perennial herb native to the tropics and cultivated in tropical countries in both hemispheres. The aromatic portion of the ginger plant is the rhizome or underground stem often referred to as the root. This rhizome has a characteristic pungent taste. For dried ginger the treatment of the rhizomes depends on whether it is to be sold as unpeeled or peeled ginger. The unpeeled product occurs in the trade as either "green" or "black" ginger. The "green" is obtained by drying the rhizomes after removing the soil and roots. To produce "black" ginger, the cleaned rhizomes are scalded in boiling water and then rapidly dried. For the production of peeled ginger, a thin layer of the skin of the rhizomes is removed with special care to prevent loss of the oil cells which are close to the surface. Ginger is one of the most popular flavoring agents.

*Marjoram.*—Sweet marjoram is a widely cultivated perennial plant native to the Mediterranean region. It is a member of the mint family. The leaves, flowers, and tender stems present a peculiarly aromatic and fragrant odor and are a very popular seasoning. They are cut as soon as the plant begins to flower.

**Spice Extractives.**—Volatile or essential oils and fixed oils or oleoresins containing the aromatic principles are extracted from spices and are a popular and convenient flavoring for meat foods. As they are available to the packing industry they possess uniform flavoring strength and therefore are more easily blended with ingredients of the meat food products

with uniform results. Most essential oils consist of mixtures of hydrocarbons (terpenes, sesquiterpenes, etc.), oxygenated compounds (alcohols, esters, ethers, aldehydes, ketones, lactones, phenols phenol ethers, etc.), and a small amount of biscid or solid non-volatile residues (paraffins, waxes, etc.). Of these the oxygenated compounds are the principal aromatic substances although the terpenes and sesquiterpenes also contribute in some degree to the total flavor value of the oil. The oxygenated substances with the exception of some aldehydes are relatively stable against oxydizing and resinifying influences and are soluble in dilute alcohol. The terpenes or sesquiterpenes due to their unsaturated character oxydize and resinify easily which destroys their flavor value. Oils in which they are present are also less soluble in alcohol.

Essential oils are generally liquid and volatile, or, upon heating, evaporate without decomposition. Their flavoring value depends on these characteristics.

Various methods of extracting essential oils are used depending on the character of the raw material. There are three methods of distillation and in the case of oils of mustard and bitter almond the crushed seeds are fermented prior to distillation. The kinds of distillation are (1) water distillation, (2) water and steam distillation, and (3) direct steam distillation. In all cases the material to be extracted is thoroughly comminuted before being placed in the still.

*Water Distillation.*—When this method is employed the material to be distilled comes in direct contact with boiling water. Some plant materials must be distilled while fully immersed and moving freely in boiling water because on distillation with injected live steam (direct steam distillation) these materials agglutinate and form large compact lumps through which the steam cannot penetrate.

*Water and Steam Distillation.*—In this method the plant material is supported on a screen some distance above the bottom of the still. The lower part of the still is filled with water to a level somewhat below the screen. The wet steam at low pressure rises through and saturates the plant material. The features of this method are that the steam is always fully saturated, wet, and never superheated, and that the plant material is in contact with the steam only and not with boiling water.

*Direct Steam Distillation.*—Live steam saturated or superheated and frequently at pressures higher than atmospheric is introduced through open or perforated steam coils below the charge through which it penetrates.

Methods other than distillation include the extraction of essential oils by pressure with or without the use of heat and by solvent methods using neutral oils, alcohol, petroleum ether, and benzene as the solvent.

When the volatile oils are extracted from the source material by its immersion in neutral oils, such as olive oil or lard, the aromatic or essential oil is finally collected by extraction with ethyl alcohol. When petroleum ether is used it is first freed from sulphur and nitrogenous compounds by washing it in turn with sulphuric acid, water, hot dilute sodium hydroxide solution, water, and then drying. Industrial benzene often contains pyridine, carbon dioxide, and thiophene which are first removed by treatment with concentrated sulphuric acid and caustic soda solutions.

The essential oils as they are supplied to the packing industry for use as flavoring materials in meat food products are concentrated flavoring oils, free of terpenes and sesquiterpenes. Such oils consist mainly of oxygenated compounds. They are more soluble, more stable, and are much stronger in aromatic quality, yet contain most of the odor and flavor characteristics of the original oil. Generally, the method used in preparing these refined oils is based on two principles; (a) removal of the terpenes and sesquiterpenes, and paraffins by fractional distillation under vacuum, or (b) by extraction of the more soluble oxygenated compounds with dilute alcohol or other solvents; in some cases a combination of the two methods is used. Essential oils commonly used in the packing industries are: oil of cardamon, oil of clove, oil of coriander, oil of cubeb, oil of cumin, oil of nutmeg, oil of parsley, oil of sage, oil of savory, and oil of thyme.

**Sucrose.—Cane Sugar.**—Sugar cane was originally indigenous to India. It has been cultivated for its saccharin juice since remotest antiquity. At the present time, it is cultivated in all tropical and subtropical countries. It was introduced into the West Indies by the Spaniards early in the Sixteenth century and these islands, especially Cuba, are now the world's largest producers. Sugar cane is cultivated by cuttings which are planted in rows and which, by giving rise to successive shoots, furnish five or six crops before the plants must be removed. At the end of a year or more the plant flowers but before this takes place the canes are richest in sugar and are cut down. The cane juice is said to contain 17 per cent of crystallizable sugar though not more than 13 per cent is extracted in practice.

When ripe, the cane is cut close to the ground, stripped of leaves and flower tufts, and transported to mills. Because of danger of inversion, the cane must reach the crusher within a few hours. At the mill the cane is cut into short pieces and these are passed through the crushers which press out the juice. The juice is strained, warmed to 93°F. and run into settling tanks for a short time.

After settling, the cane juice is still turbid, and is acid in reaction. It is treated in mixing tanks with enough lime to render it slightly alkaline, and heated until a crust of precipitated material forms. The clear juice is drawn off. It is evaporated in vacuum pans, first to a concentrated syrup and in a second operation, to crystallization. The mass of crystals still contains some water and about 82 per cent sucrose. The crystals are separated from the adhering water by centrifuging. The liquid so obtained is molasses. The crystals constitute the raw sugar shipped to refineries for further processing.

In refining, the raw sugar is mixed with mother liquor from a previous batch; this removes much of the color but does not dissolve the crystals. The crystals are separated by centrifuging after which they are washed and dissolved in a minimum of warm water to form syrup. This is treated with a little lime, heated with steam, and then filtered through a column of charcoal. The filtered liquor is concentrated to a crystalline mass in a manner similar to the treatment of raw sugar. It is then centrifuged and dried in a rotary drier to produce granulated sugar. Purification to a nearly white product can be attained by repeated washing in the centrifuge. In

some cases, it is bleached with sulphur dioxide which is added prior to the filtration through charcoal.

**Molasses.**—There are two kinds of molasses, the West India and the sugar-house. West India molasses is a black, thick liquid of a peculiar odor and sweet, empyreumatic taste. When mixed with water and with the skimmings of the vessels used in the manufacture of sugar, it forms a liquor which, when fermented and distilled, yields rum. Sugar-house molasses, also called golden drips and grocer's syrup, is thicker than the West India molasses and has a different flavor. As found in commerce it is sometimes adulterated with glucose. Both kinds of molasses contain uncrystallizable sugar, more or less cane sugar which has escaped separation in the processes of manufacture or refining, and they contain gummy and coloring matter.

**Beet Sugar.**—In obtaining sugar from the sugar beet, the root of the plant is freed of leaves, washed, and cut in slices. The term "noodles" is sometimes used to describe the slices. These are extracted with hot water and yield a dark solution containing about 12 per cent sucrose. This warm solution is treated with lime and the mixture is saturated with carbon dioxide. This causes a precipitate which is filtered out and the process is repeated until a clear liquid is obtained. This is pale yellow in color and may be made almost colorless by adding sulphur dioxide. The solution is then evaporated and the crystals washed and dried in a centrifuge. The mother syrup is concentrated and re-worked. A by-product of this operation is a molasses that contains uncrystallizable sugar and is a product similar to sugar-house molasses.

**Invert Sugar.**—The inversion of cane sugar by dilute acids is a characteristic phenomenon involving sucrose. It is called inversion because before the change takes place the sucrose is dextrorotatory, while after the hydrolytic reaction it is lævorotatory. The reaction is as follows:

$$\underset{\textit{Sucrose}}{C_{12}H_{22}O_{11}} + H_2O \rightarrow \underset{\textit{Dextrose}}{C_6H_{12}O_6} + \underset{\textit{Levulose}}{C_6H_{12}O_6}$$

The resulting solution is lævorotatory because levulose is more strongly lævorotatory than dextrose is dextrorotatory. The amount of acid that will produce the change is very small. One drop of hydrochloric acid will invert a solution containing 1 pound of sucrose in a few minutes at the optimum inversion temperature of 80°C. Commercial invert sugar which is used in food products and sometimes as an adulterant of honey is usually prepared by the use of citric acid as the inversion medium, 4 ozs. of citric acid being sufficient for 500 lbs. of sucrose. Invert sugar is sweeter than sucrose and is the cause of the cloying sweetness of some syrups and preserves in which inversion has been produced by the natural acidity of the constituents.

**Honey.**—The United States is said to be the greatest honey producing region in the world, the annual production being between 100,000,000 and 160,000,000 pounds. California is the largest honey producing State. Honey is a thick, syrupy liquid of a light yellowish to reddish-brown color. It is translucent when fresh but frequently becomes opaque and granular through crystallization of dextrose. It varies somewhat in its composition.

The principal constituents are a mixture of dextrose and levulose in the same proportions as in artificial invert sugar and in an amount ranging from 65 to nearly 80 per cent. Sucrose is present in honey in from $\frac{1}{2}$ to 8 per cent; dextrin from less than 1 to 10 per cent. Honey is usually lævorotatory.

From the nectaries of various flowers, the bee and other insects extract a thin, aqueous fluid nearly without flavor and insipidly sweet, usually known as nectar. The nectar when taken in by the bee is changed by secretions from glands in its head and thorax forming levulose, dextrose, and rarely, sucrose. The finest honey is that which is allowed to drain from the comb. Centrifugal extractors are employed to separate the honey from the comb after cleanly slicing off the ends of the cells with a sharp knife. Centrifuged honey is much cleaner than that produced by other methods. An inferior kind is procured by submitting the comb to pressure, and if heat is employed previous to expression, the product is still more impure.

**Dextrose.—Corn Sugar.**—In the manufacture of corn sugar, cornstarch is suspended in water to form a milk-like mixture which is poured into converters built to withstand a pressure of 50 pounds per square inch. The starch suspension is acidified with hydrochloric or sulphuric acid and is heated at about 40 to 45 pounds pressure until all the starch is converted to dextrose. The liquor obtained from the converter is transferred to neutralizers in which the pH of the mixture is raised to 4.8 to 5.2 with sodium carbonate. This is filtered and decolorized with activated carbon. It is then evaporated in multiple-effect evaporators, decolorized again with activated carbon, evaporated again in a single-effect unit and allowed to crystallize.

A number of types of dextrose products are prepared. However, the pressed dextrose sugar is obtained by squeezing the syrup coming from the vacuum pan in hydraulic presses. This separates most of the sugar from the dark-colored mother liquor called corn molasses or hydrol. The refined corn sugar is made by refining processes similar to those used in the cane sugar industry. The syrup from the vacuum pans is passed into warm cylindrical tanks in which it is stirred by spiral agitators so that solid lumps of crystals and dextrose hydrate cannot form. Crystallization takes place in from six to ten days. The mixture of crystals and syrup is then centrifuged, pressed through a tandem of cylindrical drum driers and sifted. This produces a product consisting of nearly 100 per cent dextrose.

**Cerelose.**—The syrup from the vacuum pan in the process described above for manufacturing corn sugar is permitted to stand at about 90°F. after being grained with pure dextrose. After crystallization has taken place, the mother liquor is removed by centrifugal methods previously described. Cerelose contains about 9 per cent water, the remainder being practically all dextrose.

**Protein Hydrolysates.**—Interest in the flavor building properties of protein hydrolysates goes back to the discovery of the processes used in the Orient to convert soy beans to soya sauce. The slow conversion of the soy bean meal portion of the basic materials used for soya sauce preparation is, in part, due to the action of naturally occurring vegetable enzymes

and the resulting splitting off of various amino acids, particularly glutamic acid. Soy bean meal contains approximately 20 per cent of glutamic acid. Oriental diets are greatly restricted as compared to those available to the peoples of other countries. The monotony of taste of the foodstuffs available to the majority of Orientals was probably responsible for the development of soya sauce.

Enzymatic hydrolysis of soy bean meal usually results in the formation of ammonia from acid amides. An Oriental soya sauce has been found to contain ammonium complexes of amino acids including ammonium glutamate. Ammonium glutamate undoubtedly plays a part in building up the flavors associated with soya sauce, and it is significant that from the time monosodium glutamate became commercially available it has been customary in the Orient to use it as a flavor reinforcement in soya sauce. The proteins that have been found to be best suited for the production of protein hydrolysates for use as food flavoring have been those that are high in total nitrogen, adequate in respect to all the amino acids, and high, particularly, in glutamic acid content. Commercially, these proteins are wheat gluten, corn gluten, extracted soy bean flour, casein, peanut flour, yeast, dried distiller's solubles, and extracted cottonseed meal. Sometimes a combination of proteins is used and it is possible to obtain a dry hydrolysate containing as high as from 16 to 18 per cent monosodium glutamate. So-called autolyzed yeast is a type of protein hydrolysate used as a food flavoring. This is prepared by hydrolyzing yeast protein through enzymatic action. Another type of protein hydrolysate used as a food flavoring is sometimes described as a complete acid hydrolyzed protein which contains a combination of all the amino acids with a high glutamic acid content. A third is the refined monosodium glutamate.

**Monosodium Glutamate.**—Glutamic acid is one of the most common of the amino acids and is a constituent of practically all proteins. Liberation of the acid from its natural sources invariably begins with a hydrolysis. This can be effected in three general ways: through the use of enzymes, heating in the presence of an acid, or heating in the presence of an aklali. The acid and alkali methods of hydrolysis are usually used in the production of glutamic acid. The processing steps are essentially (1) hydrolysis to free the glutamic acid from other substances, (2) separation of glutamic acid, (3) purification of the glutamic acid, (4) conversion to monosodium glutamate, and (5) crystallization, separation, and drying of the purified monosodium glutamate.

When monosodium glutamate was first produced in Japan it was claimed by some to possess a meaty flavor. The claim for a meaty flavor accompanied the article when it was introduced into the United States. This has given way to the belief that monosodium glutamate should be classed as a salt type of seasoning rather than as a condiment possessing a distinctive flavor.

**Saltpeter.**—This is the commercial name given to three natural occurring nitrates, (1) Chile saltpeter, cubic nitre, or sodium nitrate, (2) ordinary saltpeter, nitre, or potassium nitrate, (3) wall saltpeter or calcium nitrate. Only (1) and (2) are the saltpeters used in the meat packing industry as ingredients of meat products. The saltpeters occur in nature as efflo-

rescences resulting from the oxidation of nitrogenous matter in the presence of alkalies and alkaline earths.

Saltpeters have been used as ingredients of curing mixtures for meats for so long a period that there is no record of when saltpeter was first added to salt in the treatment of meats. It appears probable that its usefulness in curing meats was recognized following the development of a substantial saltpeter industry in Europe in connection with the production of gunpowder beginning in the Twelfth and Thirteenth centuries.

**Chile Saltpeter.**—The only commercially available natural deposits of nitrate are those covering large areas in South America, especially in the provinces of Tarapaka and Antofagasta in Chile. The areas are confined to a narrow strip 2½ miles wide and 260 miles long. The nitrates form beds varying in thickness from 6 inches to 12 feet under a conglomerate consisting of rock fragments, sodium chloride, and various sulphates cemented together by gypsum to form a hard, compact mass 6 feet to 12 feet thick. The deposit of nitrate generally has a granular structure and varies in color, being yellowish-white, bright lemon yellow, brownish, or violet. It contains from 48 to 75 per cent of sodium nitrate and from 20 to 40 per cent sodium chloride. These are associated with various minor saline components including sodium iodate, more or less insoluble minerals and also some organic matter. The organic matter consists of guano which suggests the idea that the nitrate was formed by nitrification of this kind of excrement material.

The deposit is worked up locally by extracting it with hot water. First, the suspended material is allowed to settle and then the clear liquid is drawn off to a cistern where it deposits part of its sodium chloride at high temperature. The remaining liquid is drawn off to another cistern where, on cooling, the sodium nitrate crystallizes out of solution. These crystals constitute the commercial product known as Chile saltpeter.

**Ordinary Saltpeter.**—The natural occurring potassium nitrate has no commercial value today. It occurs in the superficial layers of soil of many countries especially in certain parts of India, Persia, Arabia, and Spain. In early times these deposits furnished much of the saltpeter that was used in gunpowder manufacture. The demand for saltpeter in those days for use as an ingredient of gunpowder led to its production in France and Germany and other European countries where natural conditions were simulated by exposing to atmospheric action heaps of decaying organic matter mixed with alkalies. The salt was extracted by water and the solution treated with wood ashes. The resulting liquid was then filtered and potassium nitrate was crystallized out of solution.

Potassium nitrate is more serviceable than sodium nitrate since the latter is deliquescent. The sodium salt, therefore, is commercially converted to the potassium salt. This is done by treating the sodium nitrate with potassium chloride.

**Nitrites.**—In recent years sodium and potassium nitrite have been used as substitutes for or in combination with saltpeter in meat curing mixtures. Sodium nitrite is the one principally used and it is prepared either by reduction of sodium nitrate or as a by-product in connection with the synthesis of nitric acid from atmospheric nitrogen.

**Milk and its Products.**—Since dried skim milk[1] is a usual ingredient of cooked sausage products, in terms of quantity it is the principal milk product used in the preparation of meat food products. Dried skim milk is the food made by drying sweet skim milk, the skim milk being cows' milk from which the milk fat has been separated. Dried skim milk contains not more than 5 per cent of moisture. Spray drying is the method commonly used in the preparation of edible dried skim milk. There are two systems of spray drying, depending on the method of atomizing the skim milk in the drying chamber. In one system the skim milk is pumped under high pressure through spray nozzles located at the center of air nozzles. This accomplishes an instantaneous drying as the skim milk leaves the nozzle and the dried skim milk falls to the bottom of the drying chamber without appreciable increase in temperature. In the other method which is called the spray wheel system, the drying is accomplished by a centrifugal atomizer revolving at a high rate of speed.

Edible dried skim milk is handled in clean, tight, paper-lined barrels which protect it in transit. Inedible dried skim milk which is principally used as stock feed is shipped and handled as an inedible product, generally in unlined bags.

Skim milk, whole milk, and cream are used in the order named as ingredients of oleomargarine. When used in oleomargarine they are fresh, sweet, and pasteurized.

**Cheese, Process Cheese, and Process Cheese Foods.**—It is desirable to understand the differences that characterize the several classes of cheese products since they represent differences in moisture content. Those of high moisture content are cheaper products. Therefore, the declaration "Cheese" in an ingredient statement on a label for a meat food product would be inappropriate where process cheese, which is a cheaper product and has a higher moisture content, is used in place of cheese.

Cheddar cheese is the one most commonly used as the cheese ingredient of a meat food product. It contains not more than 39 per cent moisture and its solids contain not less than 50 per cent of milk fat. The milk used in the preparation of cheddar cheese is subjected to the action of harmless lactic acid producing bacteria present in the milk or added to it. Harmless artificial coloring is sometimes added. Sufficient rennet is added to set the milk to a semi-solid mass. At times, some milk is deficient in calcium content. This condition retards its coagulation with rennet. The addition of small amounts of calcium chloride often aids coagulation in such instances. The amount of calcium chloride does not exceed 0.02 per cent, calculated as anhydrous calcium chloride, of the weight of the milk. The mass is cut, stirred, and heated, with continued stirring to promote the separation of whey and curd. The whey is drained off and the curd is matted into a cohesive mass. This mass is cut into slabs which are so piled and handled as to promote the drainage of whey and the development of acidity. The slabs are then cut into pieces which may be rinsed by sprinkling or pouring water over them with free and continuous

[1] The official name for the commodity is "nonfat dried milk" see Public Law 646, 84th Congress.

drainage. This rinsing is limited to the removal of the surface whey only. The curd making up the slabs is again stirred, further drained, salted, and pressed into forms.

Process cheese or pasteurized process cheese is made by grinding and mixing cheese of the same or more than one variety with the addition of emulsifying agents, salt, water, and coloring, and heating the mixture to make a pasteurized product of uniform texture and composition. The one most commonly used as an ingredient of meat food product is process American cheese which is made from cheddar cheese, washed curd cheese, colby cheese, granular cheese or mixtures of two or more of these varieties. Process American cheese possesses characteristics commonly associated with process cheddar cheese with a maximum moisture content of 40 per cent and cheddar cheese constituting at least 75 per cent of the cheese ingredients.

To accomplish uniform dispersion of the fat in process cheese, certain emulsifying agents are added. Chemicals which have been found suitable for this purpose are monosodium phosphate, disodium phosphate, trisodium phosphate, dipotassium phosphate, sodium citrate, potassium citrate, calcium citrate, sodium tartrate, sodium acid pyrophosphate, tetrasodium pyrophosphate, sodium metaphosphate, and sodium potassium tartrate. These emulsifying agents are used singly and as mixtures and are limited in amount used to 3 per cent of the weight of the process cheese. The efficiency of the action of the emulsifying agent is increased by adjusting the pH of the mix through the addition of lactic acid, citric acid, acetic acid, or phosphoric acid. Reduction of the pH below 5.3 does not improve emulsifying agent action and may alter the characteristic flavor of the product.

Process cheese food is similar in appearance and taste to process cheese and is essentially process cheese to which has been added milk or certain milk products. This addition generally serves to make the process cheese food softer than the corresponding process cheese. Forty-four per cent has been identified as the maximum limit for moisture that will permit sufficient softness but prevent the use of excessive water. In order to maintain an adequate milk weight level, 23 per cent of milk fat is considered the minimum limit. An exception to this is recognized when different flavor characteristics are imparted to process cheese food by adding fruits, vegetables or meats when a minimum milk fat content of 22 per cent is recognized.

Process cheese spreads are another category of cheese product but these spreads are not commonly used as ingredients of meat food products. The soft texture characteristic of process cheese spreads is largely due to the addition of water. The maximum limit of 60 per cent moisture has been recognized. The higher moisture content brings about a reduction in the fat content with a minimum limit of 20 per cent for milk fat being set. Gums or similar water retaining substances are added to the spreads to prevent leakage of water, these include Carob bean gum, gum karaya, gum tragacanth, guar gum, gelatin, carboxy ethylcellulose, carrageen, oat gum, algin (sodium alginate), and propylene oxide ester of alginic acid. Sweetening agents such as sugar, dextrose, corn sugar, corn syrup solids,

maltose, malt syrup and hydrolized lactose are used. The acidifying agents added to process cheese spreads serve purposes in addition to enhancing the action of emulsifiers. They impart a flavor to the spread and also act as preservatives to inhibit the growth of certain bacteria. A lower pH is therefore accomplished which should not drop below 4.

**Cereal and Cereal Products.—Wheat.**—Flour milling has developed into a vast industry from its beginning centuries ago as a laborious household task. Millstones of various designs were used in flour milling until the invention in 1820 of the steel roller mill which was first used in Switzerland.

In the manufacturing of white flour, the aim is to separate the flour bearing endosperm of the grain from the bran and germ and then pulverize it to small particles. This separation can be accomplished mechanically because of differences in physical properties of the several portions of the grain. The processing steps in flour milling are wheat selection and blending, cleaning of the wheat, its conditioning and tempering, breaking, bolting or sieving, purification of the middlings, and the reduction of the purified middlings.

The miller must select and blend his receipts of wheat if he is to produce a flour of definite characteristics for the particular market that he serves. Each new crop presents special problems which require investigation of the milling and baking qualities of the wheat originating in various producing areas. After blending, the wheat is subjected to cleaning that involves the use of sieves, airblasts, and disk separators. Commercial wheat as it is received at the mill contains various impurities, such as stinking smut, weed seeds, other cereal grains, stones, soil and the like. In some instances the wheat is also washed under a stream of flowing water. After being cleaned, the wheat is conditioned or tempered by adding to it a sufficient amount of moisture to secure maximum toughening of the bran with optimum mellowing of the endosperm. The purpose of toughening the bran is to keep it from pulverizing along with the endosperm during the milling operation. In the presence of excessive moisture, however, the endosperm tends to flake rather than pulverize between the smooth rolls. Normally, hard wheat after tempering contains 15 to 16 per cent moisture.

The breaking of the tempered wheat is carried out by a series of corrugated rolls known as break rolls. A series of six pairs of break rolls is used, each successive pair of rolls possessing an increased number of corrugations and are set more closely together. The rolls operate in opposite directions at a differential in speed of about $2\frac{1}{2}$ to 1. As the rolls turn rapidly toward each other the edges of the corrugation of the more rapidly revolving roll cut across those of the slow roll so that there is a shearing as well as a crushing action on the wheat which falls in a rapid stream between them. The first break rolls are placed some distance apart so that the wheat is only lightly crushed and only a small quantity of fine flour is produced. The coarsest material is conveyed to the second break roll which crushes the material a little finer and this process is repeated until the coarser particles have passed through the six pairs of break rolls.

After each grinding on the break rolls, the crushed material is conveyed to a sifter or bolter The sifter or bolter is essentially a large box fitted with a series of sloping sieves. Three general classes of material are

separated out by this sieving operation: coarse fragments which are fed to the next succeeding break rolls until only bran remains; fine particles of flour which pass through the finest flour sieve; and granular particles of intermediate size that are called middlings. These middlings consist of fragments of endosperm mixed with small particles of bran and released embryos. They are an entirely different wheat product from the cattle feed known as middlings.

The middlings are subjected to a process called purification which separates the branny material from them. The purified middlings are then ground to flour between smooth rolls called reduction rolls which revolve at a differential of about $1\frac{1}{2}$ to 1. These rolls pulverize the endosperm fragments and flake the remaining bran fragments. By a series of rolling and sieving the flaked bran chips are removed from the pulverized endosperm. There remains after separating out the pulverized endosperm the very fine middlings and bran with a little germ. This constitutes feed middlings.

In a large mill there may be as many as 30 varieties of pulverized endosperm or flour. All these combined are known as straight flour. Frequently, the more highly refined flours are separated out and sold as patent flours while the remaining are known as clear flours. The percentage of the total flour merchandised as patent flour varies widely. When a high percentage of the more refined flours are sold as patent flours, the quantity of the remaining or clear flours becomes lower. Freshly milled wheat flour contains small quantities of yellow pigment that impart to it a creamy to yellow hue. Storing such flour at moderate temperatures accomplishes a natural aging which improves its color as well as its baking quality. Small quantities of oxidizing agents are added to freshly milled flour to bleach it and accomplish a rapid artificial aging effect. These agents include oxides of nitrogen, chlorine, nitrosyl chloride, chlorine dioxide, and benzoyl peroxide. One part by weight benzoyl peroxide is mixed with not more than six parts by weight of one or any mixture of two or more of the following: potassium alum, calcium sulfate, magnesium carbonate, sodium aluminum sulfate, dicalcium phosphate, tricalcium phosphate, starch, and calcium carbonate.

**Macaroni Products.**—Macaroni, spaghetti, and vermicelli are classed as macaroni products. They are prepared by drying formed units of dough made from semolina, durum flour, farina, flour, or any combination of two or more of these with water or with or without one or more of the following: egg white, disodium phosphate, salt, gum gluten, and flavoring such as onions, celery, garlic, and bay leaf.

The dough is kneaded into a stiff plastic mass which is translucent in thin layers and generally creamy yellow in color. The dough is transferred from the kneader to a large vertical press in the bottom of which the appropriate die or perforated plate called the trafila is located. In the preparation of the macaroni, each hole in the die has a centrally located steel pin which forms the hole in the macaroni. As the piston descends the dough is forced through the die at a pressure of from 2,500 to 5,000 pounds per square inch. Drying and curing is the most critical stage in the manufacturing process of macaroni products. The modern practice em-

ploys air currents of regulated temperature and humidity with the drying being completed in thirty-six to ninety hours. *Macaroni* is generally more than 0.11 inch in diameter but does not exceed 0.27 inch.

Spaghetti may be tubular but it is generally cord-shaped (not tubular) and it is not more than 0.11 inch in diameter but not less than 0.06 in diameter. Vermicelli is cord-shaped and not more than 0.06 in diameter.

**Noodle Products.**—This class includes noodles, egg noodles, egg macaroni, egg spaghetti, and egg vermicelli. These products are also prepared by drying formed units of dough made from semolina, durum flour, farina, and flour, but may also contain egg products in addition to water, salt, gum gluten, and flavorings such as onions, celery, garlic, and bay leaf. Noodles and egg noodles are prepared in ribbon shape while the shape and size of the egg macaroni, egg spaghetti, and egg vermicelli are the same as the products prepared without eggs and classed as macaroni products.

**Corn.**—White *cornmeal* is prepared by grinding cleaned white corn to a degree that the crude fiber content of the finished cornmeal is not less than 1.2 per cent and not more than that of the cleaned corn from which the meal was ground. The moisture content of the cornmeal is not more than 15 per cent, and its fat content does not differ more than 0.3 per cent from the corn used in the grinding process. The crude fiber and fat content represented by these figures is calculated on a moisture-free basis for the meal.

Yellow cornmeal meets the same standard as white cornmeal except that cleaned yellow corn is used instead of white corn.

Two methods of grinding corn for human consumption are used called the old process and the new process. Old process meal is also known as water-ground meal because the mills making it were formerly operated by water power. In the old process the corn (preferable white dent) is ground to a coarse meal between millstones running slowly at a low temperature. The meal is softer and more flour-like than the more highly refined new process meal. The new process is carried out with steel rolls that mill the corn along lines similar to that employed in milling wheat.

**Soya Flour.**—With the perfection of processes for the preparation of edible milled products derived from the extracted soy bean flakes, soya flour became available in large amounts for use as an ingredient of many foods including meat food products. Although soya flour does not possess binding qualities characteristic of cereal flours, it has good moisture absorbent powers and blends nicely with meats and meat by-products.

The objective of the processing method employed in the preparation of edible soya flour is to produce an extracted flake free of bitterness and a beany taste. Decorticated beans are used since the shell imparts an undesirable taste to the finished product. An alcohol extraction method has been developed to replace the one using petroleum factors. The soy bean flakes from which the oil has been extracted by ethyl alcohol have an improved color and possess less of the bitter and beany taste. The extracted flakes are subjected to a degree of heating that partially toasts them for the purpose of removing all traces of the solvent and to destroy all vestige of bitter or beany flavor. The resulting soya flour comes as near to being tasteless as can be accomplished by the method of processing.

So-called soya grits are also sometimes used as an ingredient of meat food products. Soya grits differ from soya flour only in the degree of milling.

**Vegetables.**—Fresh, dehydrated, and canned vegetables are used in large quantities in a great variety of meat food products, such as meat stews, soups, meat loaves, chili con carne with beans, and corned beef hash. They are so handled preparatory to their being used as ingredients of meat food products to assure their cleanliness, wholesomeness, and freedom from deterioration and adulteration.

**Fresh Vegetables.**—These are first sorted to eliminate those that are wilted, rotten, moldy, decayed, worm-infested, or discolored. The remaining portion is washed thoroughly in running water and then passed across a table where the vegetables are again examined to detect and remove, usually by trimming, any unfit portion.

The peeling of potatoes is done mechanically when large quantities are used as, for example, as an ingredient of corned beef hash. The methods of mechanical peeling usually used are the abrasive peeler, the flame peeler, and the lye or caustic soda method. The machine used for abrasive peeling consists essentially of an abrasive-lined drum. The floor plate of this drum revolves at a regulated speed and the drum is provided with water sprays. The potatoes are dumped into the drum and the revolving floor plate pushes the potatoes against the sides of the abrasive walls. A flow of water flushes the removed skin through a waste drain opening at the bottom. There is a continuous type of abrasive peeler in which the potatoes pass through a winding course and over the abrasive sides of rotating cylinders. The peeling and trimming loss of potatoes when the abrasive method of peeling is used may run higher than 20 per cent.

Due to the high loss experienced with the use of the abrasive peeler, another method of peeling was devised in which the potato is first subjected to the action of a boiling hot, saturated salt brine solution after which it is flamed at a temperature of around 2,000°F. for a period of from fifteen to thirty seconds. The charred surface of the potato is removed by scrubbing and washing resulting in a clean, peeled product.

The lye or caustic soda peeling results in even smaller loss. The potato is submerged in a hot solution of lye for a short time after which it is washed with acidulated water until all the lye is removed. Then the potato is scrubbed and washed removing all of the peel.

The peeled and cleaned potatoes are passed across a work table where the residual skin is removed along with the eyes, discolored areas, insect injuries, and the like.

*Dried Beans.*—As they are distributed in the trade dried beans contain varying amounts of silt, stones, pods, hulls, and stems. These are removed as part of the preparation necessary for using the dried beans as an ingredient of a meat food product. They are washed thoroughly with running water as they pass through a revolving perforated cylinder that permits the silt and smaller particles of foreign matter to pass off with the wash water. Then the beans pass through a chamber of flowing water in which baffles are so located as to trap the stones which are heavier than the beans. At the same time the lighter particles, such as pods, hulls, and stems are floated off with the waste water. After this the beans are again passed

through a perforated cylinder where they are flushed with running water as the final cleaning and any remaining foreign particles are removed here.

**Dehydrated Vegetables.**—The dehydration of vegetables, in addition to their sorting and cleaning, consists of cutting the vegetables tu the desired size and shape, blanching with steam or water, or a combination of these at boiling temperatures, to destroy enzymatic action, sulfuring with sulfur dioxide to retain high quality of product during high drying temperatures, and the process of drying.

Dehydrated potatoes are the principal dehydrated vegetable used as an ingredient of a meat food product since they are commonly used in place of fresh potatoes in preparing corned beef hash. For dehydration, many operators prefer the type of potato that becomes white and mealy with cooking.

The storage temperature of 40°F. is low enough to keep mature potatoes dormant three to five months. However, the potato may become mildly sweet under this storage condition. At lower temperatures the potatoes may show a marked yellowing and browning at the center of the piece after being dehydrated. To correct the effects of such storage conditions, the potatoes are held at temperatures of around 60°F. for approximately a month prior to dehydration during which time the sweet taste is lost and the potato loses that characteristic that produces a discolored dehydrated article. A great number of factors in addition to storage conditions affect the quality of the dehydrated potato product. Its color and texture are influenced by the maturity of the raw potato, the time and method of blanching, drying conditions, and method of rehydration. Producers of dehydrated potato products conduct tests for rehydration and quality on each lot of potatoes. An acceptable product should be rehydrated to a satisfactory plumpness without becoming mushy or watery. The rehydration weight generally runs from 2 to 4 times the dried weight for diced or cubed pieces and 3 to 5 times for julienne strips.

**Canned Vegetables.**—Canned tomato products exceed in volume all other canned vegetables used as ingredients of meat food products. The definitions and standards of identity for canned vegetables promulgated by the Federal Food and Drug Administration serve as guides in eliminating inferior canned vegetables from use in meat food products. These standards are published under Title 21 of the Code of Federal Regulations.

**Vegetable Oils.**—Large quantities of vegetable oils are used in the meat packing industry to blend with animal fats in the preparation of shortenings and oleomargarine. These oils may come to the meat packing plant as refined oils or in the crude form for refining on the premises of the plant where they are to be used. They include cottonseed oil, soy bean oil, peanut oil, sesame oil, and coconut oil.

**Oil Bearing Materials.**—The kernels of the nut of the palm, *Cocos nucifera*, are the source of coconut oil. This palm grows along the coastline of practically all the tropical regions. The kernel has a high moisture content which is favorable to enzymatic action on its fat content. Hence, it must be processed promptly if it is to yield an oil of low free fatty acid content. Copra is the dried meat of the kernel from which the coconut oil of commerce is expressed. The kernels separated from the husks are split

in half after draining off the milk; they are then exposed to the sun until the concentration of the meat of the kernel permits it to be readily removable from the shell. The separated meat is then further dried until the moisture content of the copra is reduced below 8 per cent. Properly prepared copra that is stored in dry, well-ventilated buildings will remain in good condition for some time.

Oil bearing seeds are much less subject to deterioration than the materials of high moisture content, and under suitable conditions may be stored for long periods before they are processed. However, there is a critical moisture level above which oil seeds do not keep well. Accordingly, most mills are equipped with driers to reduce the moisture content of oil bearing seeds before they are put into storage.

Oil bearing seeds whose cell structure has been damaged develop free fatty acids very rapidly. Rolled cottonseeds deteriorate markedly within a few days or even hours. Also, undecorticated seeds have much better storage properties than decorticated seeds.

Partial hydrolysis of the oil is not the only deteriorative change affecting the oil in oil bearing seeds. Other changes involve the non-oil constituents of the oil that may affect the quality of the oil. In both cottonseed and soy beans there is an increase of oil-soluble pigments which are difficult to remove in the refining and bleaching. There are also changes involving the solubilization of phosphatides or other surface active substances in the oil possibly from the splitting of protein-phosphatide complexes which may increase the refining loss out of proportion to the increase in free fatty acids. There are beneficial changes that occur in soy beans during a period of storage. The yield of oil from newly harvested soy beans is less than that obtained after a period of storage. During the storage of soy beans there is a diminution in their chlorophyll content. Chlorophyll in the oil is undesirable because of the difficulty of removing green color in subsequent processing and it becomes intensified by hydrogenation.

**Preparation of Oil Bearing Materials for Oil Extraction.**—When practical it is preferred to decorticate oil bearing seeds before they are extracted. The hulls are low in oil content and if they are not removed from the seed they tend to reduce the total yield of oil by absorbing and retaining oil in the press cake and, in addition, they reduce the capacity of the extraction equipment. Incident to their decortication the seeds are freed from dirt, sticks, leaves, and assorted trash.

Soybeans are not decorticated before they are processed for oil unless the meal is intended for human consumption. The hulls of soy beans constitute but a small part of the seed and they are relatively non-absorbent. Small oil seeds, such as flaxseed and sesame seed, are also processed without decortication.

The extraction of oil from the seeds either by mechanical expression or with the use of solvents is facilitated by reducing the seed to small particles. Rolls are generally considered to be the best type of mill for use in reducing the seeds prior to their extraction. Smooth rolls which reduce the oil seeds to thin flakes are considered most satisfactory for hydraulic pressing while flaking rolls are considered best for solvent extraction.

Cooking the oil bearing seeds causes them to yield up their oil more readily. The reason for this has not been completely explained since the changes brought about by cooking are complex both chemically and physiochemically. The oil droplets in cottonseed, for example, are almost microscopic in size and are distributed throughout the seed. One effect of cooking is to cause these droplets to coalesce into drops large enough to flow from the seed. The denaturing of the proteins by the heat and the influence of the cooking on the surface activity of the material are other factors.

**Mechanical Expression of Oil.**—The oldest and most common method of oil extraction consists of applying pressure to batches of oil bearing material confined in bags, cloths, cages, or similar devices. The pressure is applied by levers, wedges, screws, hydraulic systems, and so forth.

This type of press is giving way in the United States to presses of the expeller or screw-type which are used almost exclusively for the mechanical extraction of soy bean oil. Presses of this type are continuous and, in most respects, automatic in operation. The expeller is essentially a continuous cage press in which pressure is developed by a continuously rotating worm shaft. An extremely high pressure ranging from 15,000 to 20,000 pounds per square inch is built up in the cage or "barrel" through the action of the worm working against an adjustable pressure orifice or choke, which constricts the discharge of cake from the end of the barrel. The interior of the barrel of this machine is made of flat steel bars, which are set edgewise around the periphery of the barrel, and are held in place by a heavy cradle-type cage. The openings between the barrel bars, through which the oil must flow, can be adjusted by changing the thickness of the spacers between the bars.

**Solvent Extraction of Oils.**—Extraction with solvents obtains the best oil yields when the oil bearing material has a fairly high solids content. This method is relatively more advantageous in the processing of soy beans because of their comparatively low oil content. Also, soy beans can be rolled to thin, coherent flakes which are well-adapted to solvent extraction.

Light petroleum fractions obtained from natural gas are the most commonly used solvents. They are used both for batch extraction and in connection with continuous extraction methods.

**Refining.**—The crude oils produced by either the expression or solvent extraction method contain variable amounts of non-glyceride impurities. For example, the following have been reported as occurring in crude cottonseed oil: raffinose, pentosans, resins, proteoses, peptones, phospholipins (phosphatides), phytosterols, phytosteroline, inosite phosphates, tocopherols, xanthophyll, chlorophyll, carotenoid pigments, mucilaginous substances, and free fatty acids.

Not all of the impurities in crude oils are undesirable. The sterols, for example, are colorless and heat stable and for all practical purposes inert. Furthermore, the tocopherols perform the important function of protecting the oil from oxidation. However, most of the other impurities are objectionable. The object of refining is to remove the impurities in the oils with the least damage to either the glycerides or the tocopherols or other antioxidants.

Certain oil impurities, such as phosphatides, proteins, or protein fragments and gummy or mucilaginous substances, are soluble in the oil only in an anhydrous form and can be precipitated and removed if they are hydrated. The water washing or degumming process is similar to continuous alkali refining except that warm water is used in place of the alkali. The water and the oil to be washed are emulsified together in a continuous mixing device. After a suitable holding time, the hydrated substances and the excess water are removed by continuous centrifugation.

By far the most important and generally practiced method of refining is with the use of an alkali. Alkali-refining effects an almost complete removal of free fatty acids which are converted into oil-insoluble soaps. Other acidic substances likewise combine with the alkali and there is probably some removal of impurities from the oil by absorption on the soap formed in the operation. Also, all substances are removed which become insoluble from hydration. The alkali most commonly employed for refining oils is caustic soda.

Continuous centrifugal refining has come into wide use in the United States. In this system a continuous stream of oil and lye is fed into emulsifying chambers. The emulsion is then broken by heating it quickly to 140°F. causing it to separate into soap stock and oil which are carried to a high speed centrifuge. The oil as it comes from the centrifuge contains a small amount of dissolved and suspended soap and water. This oil is then washed by mixing it with an amount of hot water equal to 10 per cent of its own weight and this mixture is heated to a temperature of 150° to 180°F. This mixture is passed through a second centrifuge. The washed oil runs to a receiving tank and the weak soap solution is discharged into the sewer. This washing operation is sometimes repeated.

**Bleaching.**—The object of bleaching is to remove coloring materials which are relatively unaffected by refining. This treatment usually consists of bringing the oil into contact with a solid adsorbent which has an affinity for the coloring materials. These adsorbents usually consist of bleaching clay (fuller's earth) and activated carbon. Chemicals that have the capacity of oxidizing pigments to colorless forms are not used in bleaching edible oils since such chemicals also tend to oxidize and destroy the antioxidants in the oil.

**Deodorization.**—If deodorization is properly carried out the removal of odoriferous constituents from oil is substantially complete. Steam is used to remove odors from oils because of the great differences in volatility between the triglycerides and the substances which give oils and fats their natural flavors and odors. Steam deodorization is essentially a process of steam distillation wherein relatively volatile odoriferous and flavored substances are stripped by the steam from the relatively non-volatile oil. The operation is carried out at a high temperature to increase the volatility of the odoriferous components. The application of reduced pressure during the operation protects the hot oil from atmospheric oxidation and prevents undue hydrolysis of the oil by the steam.

The concentration of odoriferous substances in an oil is generally quite low. In the case of common oils such as cottonseed oil, peanut oil, and soy bean oil it does not appear to be greater than about .10 per cent.

Hydrogenation of an oil imparts a decided flavor and odor. This odor appears to be characteristic of the hydrogenation reaction as it is similar for different varieties of oil and is developed even in oils which have been thoroughly deodorized previous to hydrogenation.

Deodorization destroys any peroxides in the oil and removes any aldehydes or other volatile products which may have resulted from atmospheric oxidation. However, strongly rancid oils cannot be completely deodorized.

Deodorization is usually carried out in closed vertical cylindrical steel vessels with conical or dished bottoms. The oil in the tank is brought to a temperature of 450°F. and approximately 8 feet of head space is allowed in the deodorizer to avoid the splashing of oil over into the vapor line while it is being agitated during the process. A steam distributor is installed in the bottom of the deodorizer for breaking up and distributing the flow of injected steam. The injection of steam through the oil in the deodorizer which is under vacuum results in considerable rolling and splashing of the oil. The vapor line leading off from the top of the deodorizer is connected with a multistage system of steam ejectors which creates the vacuum.

**Mono- and Diglycerides.**—Oils and fats may be defined as those substances of plant or animal origin which consist predominantly of triglyceryl esters of the fatty acids or triglycerides. They contain three fatty acid radicals. If the three fatty acids are identical, the product is a simple triglyceride. If they are different it is a mixed triglyceride. The glycerides of fats are generally highly mixed. Monoglyceride and diglyceride contain but one and two fatty acid radicals respectively, and consequently have free hydroxyl groups. They occur naturally only in fats which have been partially hydrolyzed but they are easily prepared synthetically.

Monoglyceride and diglyceride are added to shortening to give it superior emulsifying properties. They possess marked surface activity due to their content of both lipophilic (fatty acid) and hydrophilic (hydroxyl) groups. The addition of mono- and diglycerides to shortening promotes its dispersion in the baker's doughs, particularly those with a high content of sugar.

**Lecithin.**—This is a kind of phosphatide and is one of the materials commonly removed in refining certain crude seed oils. Most of the phosphatides of commerce are derived from soy bean oil and are marketed as "soya lecithin." It is usually a stiff, waxy, dark yellow or orange-brown material containing about 30 per cent of free soy bean oil. Structurally, the phosphatides consist of triglycerides in which one fatty acid radical has been replaced with phosphoric acid. In the case of lecithin the phosphoric acid is further esterified with choline. The lipophilic portion of the molecule consists of the fatty acid radicals while the phosphoric acid-choline or phosphoric acid-cholamine complex comprises the hydrophilic group.

The phosphatides are classed with the surface active agents derived from fats and are natural rather than synthetic products. The commercial lecithins are effective oil soluble emulsifying and dispersing agents. They are used as emulsifying and anti-spattering agents for oleomargarine. Lecithin is also used as an emulsifying or surface active agent in shortening

and lard. In shortenings and lard it is also a convenient oil soluble antioxidant of the acidic type.

**Artificial Colors.—Coal-tar Dyes.**—In accordance with provisions contained in the Food, Drug and Cosmetic Act of 1938, the Food and Drug Administration has worked out a procedure that assures the use in food of only those coal tar colors that are harmless and suitable for the purpose. The Administration maintains a list of approved coal tar colors for food and it provides a certification service for batches of any of the colors so listed that are prepared for distribution and sale to food processors.

When the manufacturer of a coal tar color desires to obtain listing for a particular color with the Food and Drug Administration, his request is accompanied with pharmacological data showing that the color is harmless and suitable for the use for which it is proposed, and chemical data showing methods for determination of the identity and purity of the color. A 5-pound sample of the color produced under practical manufacturing conditions is furnished along with the request for listing and an advance deposit of $500 is made.

If, after adequate investigation, it is found that the color is harmless and suitable for the purpose for which it is proposed and proper methods are available for determining its identity and purity, an amendment to the Administration's color regulations is proposed and a public hearing is held. Based on the evidence given at such a hearing, the requested listing is either made or denied.

Each batch of a listed color which is manufactured is required to be certified before it can legally be used in a food. The Administration's certification issues only after a thorough examination of a sample from the batch shows that it meets prescribed standards of purity. Listing and certification are therefore an assurance of two things, (1) that the dye itself is harmless and (2) that the particular batch is free from harmful impurities.

The general requirements for certification by the Administration of a batch of coal tar color intended to be used in coloring foods are:

1) Freedom from all impurities to the extent that such impurities can be avoided in good manufacturing practices.

2) It must be a listed coal tar color.

3) It does not contain more than 0.00014 per cent arsenic, 0. 001 per cent of lead, and a trace of heavy metals.

If a sample representing a batch of listed coal tar colors is found after adequate investigation by the Administration to comply with its requirements, the Administration issues a certificate covering the batch in question. This certificate assigns a lot number to the batch and shows the pure dye content found in the batch.

The following information is required to be contained on the label for a coal tar dye intended to be used as a food coloring:

1) An accurate statement of the net contents of the package.

2) The name and place of business of the manufacturer, packer or distributor.

3) The name of the color components and that of each diluent contained in the mixture.

4) The name of the color.
5) The lot number of the batch.
6) The pure dye content of the color.
7) In the case of a color certified for only a limited use a statement setting forth this limitation.

The person to whom the certificate is issued is required to keep records, to show the quantity of color used, the date, and kind of use, and the shipping records including the name and address of the person to whom shipment was made. This information is required to be produced at the request of a representative of the Food and Drug Administration until one year after disposal of the batch.

**Vegetable Coloring.**—*Alkanet.*—Alkannin is the coloring principle of alkanet root and is brownish-red in color with a coppery luster. It is almost insoluble in water but is soluble in alcohol, ether, or fixed oils. The alkannin is found most abundant in the cortical region of the alkanet root. The root is obtained from a herbaceous perennial plant indigenous to Asia Minor and southeastern Europe.

*Annatto.*—This is a brownish-red color derived from the reddish pulp surrounding the seeds in the fruit of Bixa orellana L., a medium-sized tree native to northern South America but widely cultivated in tropical Asia and Africa. The coloring principle does not dissolve in water but imparts to it a yellow color. It is soluble in alcohol, oils, and alkaline solutions. It contains two coloring principles, one known as bixin, which when pure is dark red and the other is a yellow coloring matter, orellin, which is probably a decomposition product of bixin.

*Cochineal.*—Cochineal solution is obtained from an insect indigenous to Mexico, Peru and Central America that has the general appearance of a wood louse. The red dye is found in the dried remains of the female insect. Cochineal solution is very dark purplish-red in color. This changes to orange upon being acidified with hydrochloric acid and returns again to red purple upon being made alkaline.

*Saffron.*—The chief coloring agent in saffron is the glycoside crocin. This is a yellow powder easily soluble in water. Saffron is a perennial plant, Crocus sativus. The plant is believed to be a native of Greece, Persia, and Asia Minor. At present, saffron is chiefly cultivated for medicinal use in Spain. In the United States it is cultivated as a garden flower.

*Turmeric.*—Turmeric yellow or curcumin is obtained from the rhizome of the Curcuma longa L. which is a plant native to southern Asia and the East Indies but now cultivated particularly in China, Bengal, and Java. Turmeric is used for dyeing yellow but the color is not permanent.

**Chemical Preservatives.**—Historically, the use of chemical preservatives in foods has been supported and condemned by many authorities. Out of its checkered career has emerged what appears to be a sound philosophy that begins by distinguishing between those substances that are chemical in nature but which serve traditionally as flavoring and processing materials, and chemicals whose only use is to inhibit deteriorative changes in food. Reserving the designation chemical preservatives to identify those chemicals that serve only to retard deteriorative changes in food, there is identified a class of substances which is subject to definite rules for con-

trolled use. Generally speaking, their rigid control is justified because they are used as a substitute for clean and careful food processing practices and they tend to mask inferiority; furthermore there is insufficient knowledge concerning their complete mode of action. In recent years the only chemical preservatives that have gained acceptance for use in products of the meat packing industry are benzoic acid and sodium benzoate in oleomargine.

**Benzoic Acid and Sodium Benzoate.**—The Wiley report of 1908 pointed up a controversy that had developed between food manufacturing interests and food control officials concerning what had become a rather prevalent practice of using chemical preservatives in foods prior to that time. Mr. Wiley's campaign against the use of chemical preservatives in foods emphasized the consumer demand for cleanliness in food preparation accompanied with proper processing methods. Benzoic acid and sodium benzoate became the center of controversy, with Mr. Wiley concluding on the one hand that they are highly objectionable and poisonous, while the Remsen[1] Referee Board Report of 1909 concluded that they are relatively harmless. Although benzoic acid and sodium benzoate were permitted to be used in all meat food products prepared under Federal meat inspection until 1948, these preservatives had only a very limited use. By regulation in 1948 their use is limited to oleomargarine. The acidity of the medium in which these preservatives work is very important. Their usefulness in meats at the usual range of pH for fresh meats is highly questionable.

**Antioxidants.**—When fats are exposed to the air they tend to oxidize and produce the condition called rancidity. This condition is accompanied with typical off odors and flavors produced by the oxidation. All fats have this tendency to become rancid but there are factors which influence the rate of occurrence. Some of these factors are the chemical composition of the fat, the method of processing, the method of packaging, the conditions of storage, and the presence or absence of naturally occurring antioxidants in the fat. Antioxidants are substances which when present in fats will delay the onset of rancidity. They stabilize the fat toward oxidation. Some fats, such as certain vegetable oils, contain naturally occurring antioxidants. Other fats, such as lard, contain very little antioxidant material. Synergists are used in combination with the antioxidants to improve their efficiency.

*Lecithin.*—This is one of the phosphatides naturally occurring in crude vegetable oils. It is only moderately active as an antioxidant. It is inexpensive and relatively easily mixed with the rendered fat. The maximum stability effect of lecithin is accomplished with 0.075 per cent of the lecithin in the rendered fat.

*Resin Guaiac.*—This is also relatively inexpensive and may be used in concentrations up to 0.10 per cent. It is a rather effective antioxidant and possesses the outstanding advantage of its antioxidant effect carrying over into the baked and fried goods made from the treated fat. Resin guaiac has several disadvantages, however. Some of these are its odor and flavor

[1] I. Remsen "Influence of Sodium Benzoate" United States Department of Agriculture Report No. 88 (1909)

which must be removed by deodorization of the treated fat. It is also quite insoluble in the fat which presents the problem of incorporating it uniformly in the treated fat.

Resin guaiac exists as a physiological product filling up the tissues of the wood of Guajacum officinale, a middle-sized or low evergreen tree indigenous to the West Indies and the northern part of South America. It is obtained in several different ways, the most simple is by spontaneous exudation.

*Tocopherols.*—Tocopherols, or vitamin E, are effective stabilizers for fats. They are easily mixed with the rendered fat and they do not impart any color, odor, or flavor. They occur naturally in crude vegetable oils and are produced as part of the refining process of these oils. It is generally accepted that tocopherols are primarily responsible for the stabilities of the vegetable oils. Concentration of tocopherols up to 0.03 percent of the rendered fat are used, however 0.01 percent have been found to produce good stability in rendered fats.

Tocopherols are carry-through antioxidants in lard. That is, the antioxidant property carries through to the baked goods. Gamma tocopherol appears to have better antioxidant properties than alpha tocopherol. The gamma is also a better carry-through antioxidant.

*Nordihydroguaiaretic acid.*—Nordihydroguaiaretic acid was discovered at the University of Minnesota in 1942. It is extracted from the creosote bush which is indigenous to semi-arid areas in parts of western United States.

*Propyl Gallate.*—This is the propyl alcohol ester of gallic acid and is a very effective antioxidant in rendered fats. It is used in concentrations up to 0.01 per cent. Its stabilizing action does not carry over into the baked goods prepared with the treated fat, due, probably, to its solubility in water. It is heat stable and deodorization does not lower the stability of fats to which it is added. Propyl gallate does not affect the color of the rendered fat to which it is added nor does it impart odor or flavor to the fat.

*Thiodipropionate Group.*—Thiodipropionic acid, dilauryl thiodipropionate, and distearyl thiodipropionate, singly or in combination in quantities up to 0.01 per cent of thiodipropionic acid and 0.09 per cent of either dilauryl thiodipropionate or distearyl thiodipropionate, or combinations of the two in rendered fat, are effective antioxidants. The esters are more fat soluble than the acid and their effect carries over into the products prepared with the treated fat. This carry-over effect has not been experienced with the acid. When the rendered fat is to be deodorized, the esters should be added after completion of the deodorization. On the other hand, the acid should be added to the fat prior to deodorization so that it may be present during that process.

*Butylated Hydroxyanisole.*—This is a mixture of 2-tertiarybutyl-4-hydroxyanisole and 3-tertiarybutyl-4-hydroxyanisole and is an effective antioxidant in rendered fat when used in amounts up to 0.02 per cent.

*Citric Acid and Phosphoric Acid.*—These are not true antioxidants, however, they are added to rendered fats for their synergistic effect. They improve the stabilizing activity of the antioxidants normally present in the rendered fat as well as the added antioxidant. Since lard, for example,

contains little or no naturally occurring antioxidants, the addition of citric acid or phosphoric acid has no value. On the other hand, their addition to vegetable oils which contain natural antioxidants or rendered animal fats to which antioxidants have been added has an improved stabilizing effect.

**Starter Cultures.**—In years past a manufacturer of fermented sausages such as summer sausage, thuringer, and salami largely depended upon chance inoculation with the fermentive organism. Frequently spoilage of the product occurred because of contamination with undesirable organisms. Furthermore, this method of relying on chance inoculation with microorganisms of unascertained types often led to undesirable taste results.

Most fermented foods are prepared by a method that includes controlled fermentation. The responsible microorganism is identified and pure cultures are deliberately added to the food.

A starter culture must possess a unique combination of characteristics. The culture must grow vigorously in the sausage. It must be salt-tolerant and capable of anaerobic growth. While producing the desired quantity of acid and accompanying tangy flavor, the culture must not produce large quantities of gas or off-odors or flavors as a result of its metabolism. The starter culture must be non-proteolytic. It must be able to grow in temperature ranges employed in commercial smoking schedules.

Harmless bacterial starters of the acidophilus type are used in the preparation of such kinds of sausage as thuringer, lebanon bologna, cervelat, salami, and pork roll. The amount added to the product does not exceed one-half of 1 per cent. The *pediococcus cerevisiae* has also been developed for use as a starter culture.

**Polyphosphates.**—This term has been used loosely to refer to a variety of phosphates that have been accepted for use as ingredients in foods, notably cheese and meats. Commerical phosphate preparations are as a rule mixtures of the different types of phosphates, that is, of ortho-, pyro-, and metaphosphates. These salts are mixed to obtain the desired pH level or to make insoluble phosphates soluble through the addition of other phosphates. The phosphates that have been accepted for addition to meat products under the Federal meat inspection program are listed on page 439.

It is interesting to note that a polyphosphate occurs in living (or surviving) muscle; namely, adenosine triphosphate (ATP) which is of extremely great physiological importance. A significant effect of the phosphates on proteins has to do with the so-called "hydration" of the protein, that is, the interchange between the protein and water. An increase in hydration results in greater water absorption by the protein characterized by swelling and stronger retention of the water taken up by the protein. Conversely, a lowered hydration means less swelling with a decrease in water binding power.

At the time of slaughter the muscle tissue has close relationship with the phosphate and it has a high hydration quality. After slaughter the meat tends to lose this hydration quality as the close phosphate protein relationship is affected by the action of such salts as calcium and magnesium which, through their association with the protein weakens its hydration properties. The addition of the polyphosphates and sodium chloride tend to restore

some of the hydration qualities which the muscle had originally. The salt is essential to this result since it appears to supply the proper ion concentration to facilitate the sequestration of the calcium and magnesium salts by the phosphate

Phosphates have found a valid use as ingredients of curing solutions for pork cuts. Pork cuts such as cured hams so treated can be subjected to high temperatures during the smoking process without sacrificing quality of product.

The use of phosphates has raised problems not previously encountered in meat curing. The precipitation of phosphates in concentrated brine solutions has presented some difficulty in their use. Also phosphate crystals tend to form on the cut surface of the finished product. Adjustments in the curing solution have succeeded in correcting these conditions. Also, curing solutions containing phosphates tend to be corrosive. It has been found advisable to use plastic or stainless steel lines for the phosphate pickles. The anodized can (p 416) is helpful in reducing the corrosion on canned hams prepared with added phosphate.

**Ascorbic Acid.**—Ascorbic acid and a number of its derivatives are used as ingredients of curing preparations. The effectiveness of these materials in meat curing is proportional to their activity as reducing agents. They are not preservatives in that they have no significant effect on the bacteria in meat. They will neither promote nor prevent souring, sliminess, greening, or other spoilage due to bacteria or molds.

The ascorbic acid remaining in the finished product after the curing process serves as a reducing agent in retarding the fading of the cured meat pigment by reacting with oxygen in preference to the oxygen bleaching the red pigment. This action improves the red color and retards the loss of color, but it does not protect the color indefinitely. Color fading under display conditions is a very rapid process compared to spoilage processes. It is highly unlikely that color fading would be delayed by ascorbic acid to such an extent that the product would be spoiled bacteriologically and still have an acceptable appearance.

In general, when ascorbic acid is used the smoking time for frankfurters, for example, can be reduced by as much as 40 per cent and for a large bologna as much as 25 per cent. With the use of ascorbic acid, color development is accelerated and it is unnecessary to raise the temperature in the smokehouse as gradually as with the conventional methods.

The rate of color fading in sliced cured product depends on several factors. These include the amount of oxygen in the product and in the package, the amount of surface exposed, the intensity of the light in the display case, and the presence and quantity of reducing agents in the product. It is difficult to predict just how long ascorbic acid will protect a cured product against color fading. The product usually has a better color initially and will hold the color several hours longer under rigorous display conditions.

**Smoke.**—Smoke is, of course, a chemical additive that is used in the processing of food Due to its long-continued and traditional use in this connection, there is a presumption of safety connected with its use. This presumption will come in for review from time to time as the chemical additive subject receives more and more attention. Feeding experiments

have been conducted with mice that have been given strongly smoked meat as their sole source of food. No symptom of ill health was observed in connection with these feedings. Although these experiments must be considered as reassuring, they cannot be regarded as conclusive. Smoke will no doubt come in for its share of attention as new chemical additive legislation is enforced.

**Vinegar.**—As employed in foods, vinegar is essentially a bacterial fermentation product of certain fruit juices, such as apple, grape, tomato, or other kind of fruit.

The fruit juices are first subjected to an alcoholic fermentation by employing a yeast. The alcohol is then converted to acetic acid by the vinegar bacteria (acetobacter). The conversion of alcohol to acetic acid is an oxidative step.

Usually, for household purposes, vinegar is prepared which contains 4 to 5 per cent acetic acid. The oxidized hard cider is filtered and pasteurized to prevent scum formation resulting from further growth of the vinegar bacteria and to kill the harmless "vinegar eels" (nematodes) which thrive on the vinegar bacteria.

For industrial purposes, much stronger vinegar is prepared by trickling distilled alcohol diluted with water through a series of several towers lined with beech shavings or some other similar material. The shavings become impregnated and coated with the vinegar bacteria which convert the alcohol to acetic acid.

The final product is clarified and usually adjusted to a concentration of 10 per cent acetic acid. This is the product commonly used for the pickling of pigs feet and sausages. It is preferred because of its high degree of clarity and is commonly known as white distilled vinegar. It consists of little more than an aqueous solution of acetic acid.

The strength of vinegar is usually reported in terms of "grains." Although some confusion has existed with respect to the derivation and use of this term, the grain strength of vinegar denotes a 10-fold concentration of acetic acid expressed in percentage. For example, 100 grain white distilled vinegar is an aqueous solution containing 10 per cent acetic acid.

Chapter

# 10

# PREPARATION OF MEATS AND MEAT FOOD PRODUCTS

WHOLESOME, disease-free meat, poultry meat, and meat by-products move from the inspected slaughtering department to the processing departments of the packing plant. Where the inspection supervision is adequate, the processing departments are so constructed, equipped, and maintained as to assure a clean and sanitary environment for the processing of the meats and meat food products.

Additional inspection supervision is necessary, however, to assure that the processes employed are those that are normal for the particular products. The process of manufacture is not permitted to impair the wholesomeness of the product. It must not result in its adulteration, either by adding a substance not normal to the product or by failure to remove a substance normally removed during the process of manufacture. Furthermore, the process is not permitted to impart a deceptive character to the finished product.

To accomplish this, it is necessary that the inspector know what is the normal process of manufacture for each product and that he is alert to those steps in the processing of the particular product where deviations from the normal might occur. With this knowledge he is able to plan his inspection routine so that it may be an efficient one and result in an effective supervision over the handling, processing and packaging of the meats and meat food products preparatory to their being shipped to the trade.

**Chilling.**—It is common knowledge that meat will not keep for a long time unless it is thoroughly chilled. Fresh meat, therefore, is chilled so that a temperature just above freezing is attained in all parts of the article. This temperature is maintained throughout the meat until it is either delivered to the consumer or it enters into a process of manufacture. At temperatures below freezing, for example, 15°F., meat will keep for a long time in excellent condition. This temperature, however, imparts a hard, frozen condition in the meat which, upon thawing produces characteristics of the meat that are considered less desirable than those possessed by properly chilled meat that has not been frozen.

The properly dressed carcass as it is placed in the refrigerated compartment from the slaughtering department is warm and moist. It offers ideal conditions for the growth and multiplication of spoilage organisms. In fact there is a slight rise in the temperatures of the heavy tissues after death. This is due to the heat generated by the glycogen-lactic acid reaction which has as one of its results the lowering of the pH of the muscle tissue.

Quick chilling of the carcass is imperative in order to check and prevent the growth of spoilage orgaisms. It was once thought that a carcass could be chilled too quickly. It was believed that if the carcass were chilled too quickly a sort of casing would be formed on the outside of the carcass that would cause the animal heat to remain in the carcass by interfering with an interchange of the animal heat with the refrigerated atmosphere surrounding the carcass. It is now generally conceded that there is no such thing as chilling the carcass too quickly provided no portion of it is frosted. The best practice now is to chill carcasses to an internal temperature of 34° to 36°F. as soon as possible. The underlying principle of quick chilling is rapid circulation of air at low temperature and controlled humidity. A temperature as low as 20°F. is sometimes used in chilling heavy beef carcasses. As the chilling of the carcass progresses the surrounding temperature is, of course, adjusted so as to prevent freezing the meat.

Rapid chilling of the meat has the objective of inactivating the spoilage organisms during the initial stationary phase of their development and the lag phase during which the organisms begin to divide slowly before the logarithmic phase which is the period of most vigorous growth. It may be that such chilling also effects a cold shock on the spoilage organisms in the meat. Although this has not been worked out conclusively, there is indication that such cold shock actually reduces the number of organisms present.

**Cutting.**—The dividing of the chilled carcass into its various commercial parts is generally referred to as the cutting operation. The products of the cutting department move in several directions—the fats to the rendering department, fresh cuts of meat directly to the trade, fresh cuts of meat to the curing department, and other meat is processed into many kinds of sausage products, so-called delicatessen products and jarred and canned foods.

Figures 100 to 103 require very little explanation. The charts showing the location and names of bones with relation to the commercial subdivisions of the carcasses of the several species are useful because it is important to be able to visualize the bone structure where the dividing cut is made. Also it is useful to know the bone content of each cut.

The beef fillet from which the fillet mignon is prepared is not illustrated among the wholesale cuts on the beef chart (Fig. 104). This fillet consists of the psoas major and psoas minor muscles. When this cut is removed from the loin it cannot be used for sirloin steaks, porterhouse, and T-bone steaks. The loin is then called a shell and the steaks cut from the shell contain only the so-called tail of the steak and the meat dorsal to the transverse process of the lumbar vertebra.

**Freezing.**—A temperature of 15°F. was used for freezing and storing meats until the early 1900's. With the development of better refrigeration equipment and insulation, and the recognition that good quality of the meat is retained at lower temperatures, the freezing of meat is accomplished in air temperatures of −10°F. and lower in a rapid movement of air. After freezing, the meats are stored in temperatures of 0°F. or lower.

In the distribution of frozen foods a constant environment of 0° F. or below is regarded as being a good goal. This provides a margin of safety that should assure the maintenance of the food in a frozen state until it

reaches the consumer. There are a number of patents on temperature-sensitive markers to be applied to frozen food packages. These are called defrosting indicators which change color or otherwise indicate when the article to which they are applied reaches a temperature above a certain limit. These markers have not come into general use because it is said that they do not provide a true index of temperature experienced by the food itself. For example, the marker may reflect a purely surface condition. Sufficient surface defrosting of a package to be reflected by the marker can

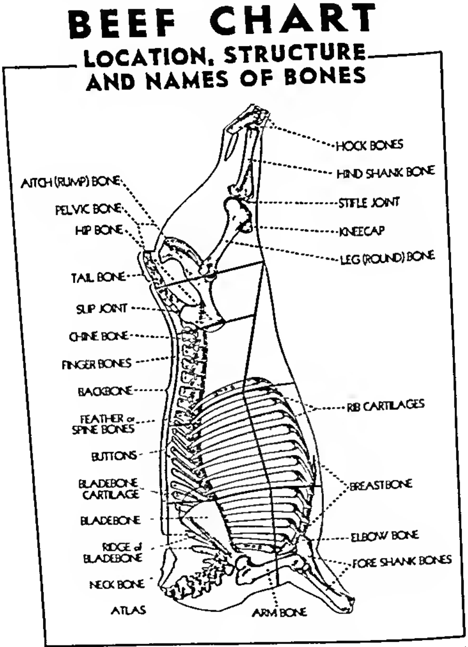


FIG 100 — Beef chart, location, structure and name of bones. (National Live Stock and Meat Board.)

occur even in the consumers hands between the time of purchase and the time the package goes into the home freezing unit.

Meat that has been quick-frozen to a temperature of −15°F. by comparison with meat frozen to a temperature of 15°F. has a lighter and more desirable color in the frozen state. Also, the meat quick-frozen at the lower temperature tends to retain its juices better and is firmer after thawing. Some claims are made for an improved tenderness of the meat that is quick-frozen to a lower temperature.

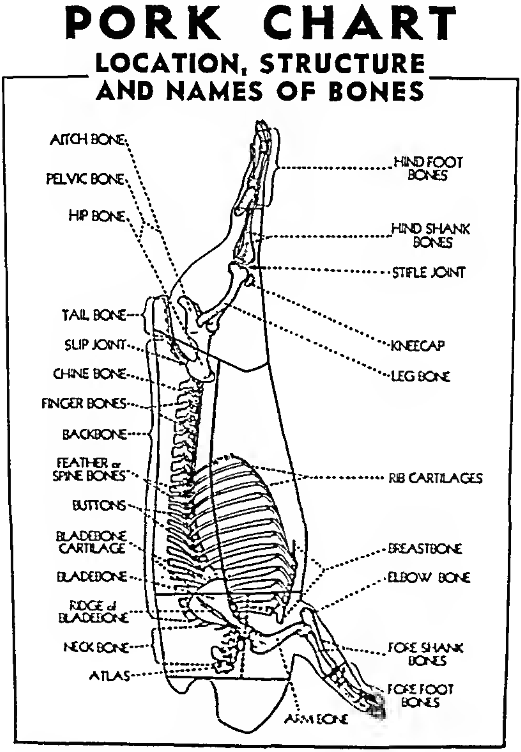


FIG. 101.—Pork chart, location, structure and name of bones. (National Live Stock and Meat Board.)

The size and location of ice crystals in frozen meats depend on the rate at which the temperature of the meat is dropped from just above the freezing point to a temperature of about 25°F. Small intrafiber ice crystals form in the quickly frozen meats and large extrafiber ice crystals are characteristic of slowly frozen meats. In beef, aging before freezing is also a factor. Large extrafiber ice crystals form when aged beef is frozen. However, the aging of beef appears to improve the ability of the defrosted muscle tissue to reabsorb some of the "frozen out" water.

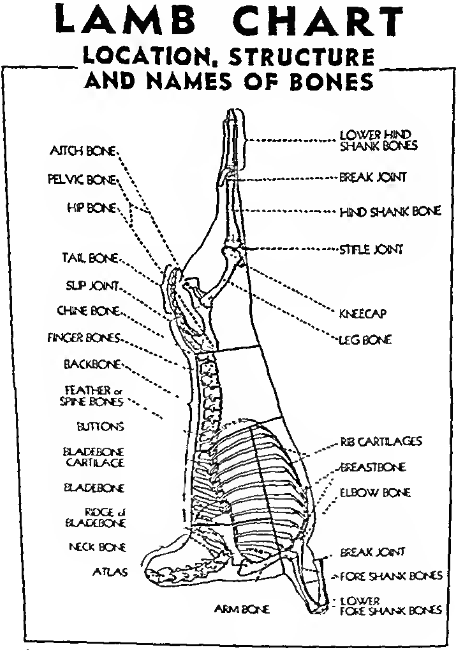


FIG. 102 — Lamb chart, location, structure and name of bones. (National Live Stock and Meat Board.)

When meats are frozen at a temperature just below the freezing point the freezing progresses very slowly. Ice crystals ½ inch long and ⅛ inch thick have been observed in beef after several weeks at a temperature of 28°F. On the other hand beef steaks ½ inch thick derived from freshly killed beef when frozen within a few minutes at a temperature of –30°F. showed very small intrafiber ice crystals.

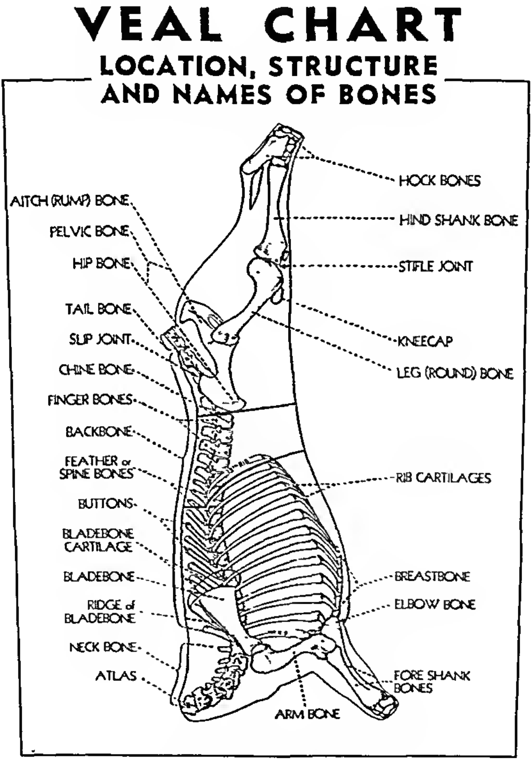


FIG. 103 —Veal chart, location, structure and name of bones. (National Live Stock and Meat Board.)

The color of frozen meat is determined by the size and location of the ice crystals. Color differences in frozen meat, therefore, disappear when the meat is thawed. Beef steaks quick-frozen at very low temperatures have been observed to possess a color lighter than the fresh meat. Steaks slow-frozen at 20°F. were observed to be darker than the fresh meat. Steaks quick-frozen at −20°F. possess a color comparable to the fresh steaks.


FIG. 104 Beef chart, wholesale cuts. (National Live Stock and Meat Board.)

**Defrosting** Large quantities of fresh pork cuts, such as hams, picnics, pork butts, and pork loins, are placed in the freezer each year during the season when there is a heavy run of hogs. These are to be taken out later for distribution to the trade or for processing into cured and smoked prod-

ucts when the hog runs are comparatively light. Large quantities of frozen pork cuts are defrosted as they are removed from the freezer. Progress in defrosting in recent years has resulted in methods of handling which avoid deterioration of the product as its temperature is elevated.

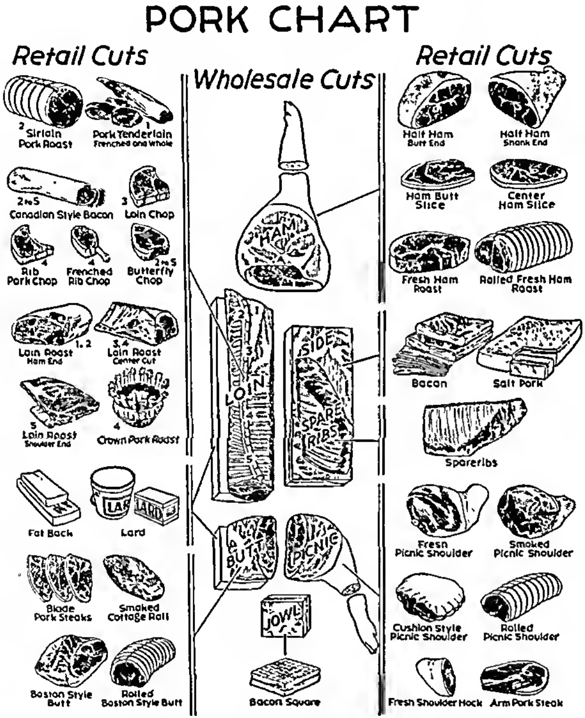


FIG. 105.—Pork chart, wholesale cuts. (National Live Stock and Meat Board.)

Frozen meat is no longer placed on racks in a warm atmosphere since defrosting under these conditions tends to elevate the temperature of the surface of the meat to the point that favors spoilage before the interior of the meat is adequately defrosted. The practice now widely employed involves the use of vats in which the frozen meat is defrosted in circulating

water at temperatures up to 90°F. By carefully controlling the temperature of the water and its circulation throughout the tank in which frozen meat cuts are placed for defrosting, the temperature of the meats can be raised to desired temperatures promptly when they are removed from the defrosting equipment before deterioration sets in.


FIG. 106 —Lamb chart, wholesale cuts. (National Live Stock and Meat Board.)

**Aging.**—Pork, veal, lamb, and mutton that are intended to be sold to the consumer in a fresh, chilled condition pass through the meat packing plant as quickly as their chilling and preparation for the trade can be accomplished. Certain classes of beef, on the other hand, are frequently held for relatively long periods of time for the purpose of effecting changes in tenderness and flavor which are desired by some consumers. This

holding is done under controlled conditions of temperature and humidity and it is the process called aging of beef. It is generally conceded that meat contains enzymes capable of digesting it, and this process of digestion is usually referred to as autolysis. This aging of beef might be considered as being accomplished by the process of controlled autolysis.


Fig. 107.—Veal chart, wholesale cuts. (National Live Stock and Meat Board.)

Satisfactory results are obtained in aging beef when temperature and humidity are rigidly controlled. The optimum temperature has been found to be 36°F., and a relative humidity of 85 to 87 per cent is generally used. The frequency of air change is about 7 times per hour. Beef aged under these conditions will present a minimum of deterioration through de-

hydration and discoloration of the surface tissues. Beef is aged from three to six weeks under these conditions depending on the tastes of the consumer.

During the holding period care is exercised to avoid any variation in temperature which would cause the beef to become moist and sticky. For example, the meat is protected from drafts of warm air such as might enter through open doors.

There are three different conditions that affect the beef during the process of aging. First, the enzymatic action which, if properly controlled, accomplishes the purposes of normal aging. Second, micro-organisms on or in the meat multiply and attack the tissues. The growth of the micro-organisms is held in check by the rigid temperature controls. Third, oxidation changes occur that result from exposure of the surface of the meat to the atmosphere. These changes are usually too slow to be noticeable in the holding periods commonly employed.

In recent years a method of handling beef has been developed that accelerates the so-called aging process. This method is based on the principle that as the temperature of the medium rises above freezing, marked acceleration of the enzymatic action occurs. The method also employes a controlled enzymatic action, using exact temperatures and exposure time.

The dressed carcasses of beef intended to be subjected to the accelerated aging process are chilled promptly as they leave the slaughtering department. However, instead of being chilled to temperatures just above freezing, the temperature of the beef is not permitted to drop below 54° F. The optimum temperature is one that ranges from 54° to 59°F. throughout the beef. This beef is then placed in an atmosphere with a temperature of 68°F. A relative humidity ranging from 80 to 85 per cent is maintained in the air surrounding the carcass and its velocity is from 50 to 75 feet per minute. Under these conditions the internal meat temperature increases 0.50° to 0.75°F. per hour and reaches 66°F. after eighteen to twenty-two hours. The beef is removed from the quick aging room after it has been held forty-four hours, with an absolute maximum of forty-eight hours. It is then re-chilled promptly to reduce its temperature to just above freezing within not longer than twenty-four hours.

An additional precaution is employed in the quick aging process of beef having for its purpose the control of the growth of micro-organisms on the surface of the beef while it is exposed to the 68°F. temperature. It is inevitable that spoilage organisms will be present on the surface of the beef and they will grow rapidly under the conditions of exposure in the quick aging room. To check this growth, all surfaces of the beef are exposed to ultra-violet irradiation produced by lamps that provide an effective bactericidal radiation.

The ultra-violet lamps incidentally produce varying amounts of ozone depending on the kind and type of lamp. The lamps selected for use in the quick-aging room are of the kind that produce a minimum amount of ozone. This is important to protect the personnel in the room from exposure to unsafe quantities of ozone. Also, excessive amounts of ozone in the air tend to mask odors and affect of the sense of smell, thereby constituting an interference with inspection While small amounts of ozone have been

accepted in quick-aging rooms as being incidental to the use of the ultraviolet lamps, no ozone is permitted to be generated in the atmosphere of other meat handling departments.

**Meat Tenderizer.**—The active ingredient in most commercial tenderizers is papain. It is a plant enzyme obtained from the papaya. The proteolytic action of the enzyme cleaves or breaks apart the muscle fiber proteins and connective tissue of meat by hydrolysis.

After application of the enzyme to the meat and cooking the meat, marked changes are found in the tissue. Not only is the sarcolemma destroyed at the surface of the product leading to marked separation of muscle fibers, but in some cases, the fibers have coalesced. Only deep down in the meat are indications of the sarcolemma found. Likewise, the nuclei of the muscle fibers were apparent only at a considerable distance from the treated surface of the meat. Subsequent stages in hydrolysis involve the appearance of small open spaces in the muscle fibers.

There is indication that effective distribution of papain within the meat cannot be accomplished by natural diffusion or by papain's hydrolytic activity. Also, there is indication that a holding period of from one to five hours before cooking has no significant effect.

The studies of papain action, the effect of temperature on papain activity, the hydrolysis of beef proteins, and the effect of precooking holding periods on beef tenderization indicate that precooking holding periods are unnecessary. The studies further indicate that incorporation of papain into meat to be tenderized is a most important problem. Physical means of incorporation should be used and perhaps, the technique of thoroughly working papain into meat may be a solution to this problem.

Probably the most important tenderization mechanism is the hydrolysis of muscle-fiber protein which accounts for three-quarters of the edible portion of meat. Papain hydrolyzes the sarcolemma and the muscle cell nuclei before there is any apparent digestion of the muscle fibers themselves. As measured by the transformation of soluble proteins to amino acids, papain hydrolysis reaches a maximum at temperatures of 140° to 176° F. It is probable that the heat-labile muscle proteins denature before the relatively heat-stable papain hydrolysizes these denatured proteins with maximum effect. Tenderization by papain cannot be ascribed to one specific reaction but rather to a general hydrolysis of all of the structural components of meat muscle. Any proteolytic enzyme can be a potential meat tenderizer. In addition to papain, there is a proteolytic enzyme derived from the pineapple plant and known as "bromelin", also proteolytic enzyme preparations are available that have been derived from other sources such as bacteria and fungi.

Structural changes observed during the tenderizing process are (*a*) thinning and dissolution of the sarcolemma, (*b*) disintegration of the nuclei of both the muscle fibers and connective tissue cells, and (*c*) finally, disintegration of the cross-striations of muscle fibers leading to a mushy state of the tissues.

**Dehydrated Meat.**—Theoretically, it should be possible to preserve meat by dehydration just as satisfactorily as other foods. The commercially dehydrated meats produced prior to and during World War II were reasonably

acceptable products. The best dehydrated meats were obtained by cooking, grinding, and drying as rapidly as possible at temperatures below 70°C. Small particles, precooking at low temperatures ranging from 165° to 212° F., and low fat content contributed to rapid drying and high rehydration of the dehydrated product. However, these dehydrated meats resorbed water only to the extent of 60 grams per 100 grams of dried meat under their rehydration conditions (one hour at 28° to 30° C.). None of the pre-cooked, ground, dehydrated beef or pork produced commercially during World War II would rehydrate to the moisture level of the precooked meat.

The gross chemical composition of meat on a moisture-free basis (beef, pork, mutton) was apparently little changed by dehydration. When the pre-cooking was carried out under pressure, soluble phosphorous and non-coagulable nitrogen in the final product were increased. Also, it was found that loss of water soluble nitrogen compound increased when the dehydration was performed at higher drying temperatures. Conversion of water soluble compounds to insoluble compounds contributed to flavor loss during dehydration.

The only significant loss from a nutritive standpoint during dehydration of meat was in thiamine and pantothenic acids. Biological value and digestibility of the protein were not adversely affected by dehydration of meat. Flavor deterioration in storage was considered to be associated with changes in the protein fraction of the dehydrated meat.

**Freeze-dehydration.** —Slices of raw meat frozen at −80° C. and then dried under vacuum were almost completely dehydrated in nine hours. The meat rehydrated rapidly to the original moisture content and in gross physical characteristics was almost indistinguishable from fresh raw meat. Muscle fiber diameter changes parelleled the moisture changes closely which shows that the meat dried by the freezing technique reconstituted in the true sense. Histologically, the organization of frozen dried raw beef was somewhat different from that of undried raw beef but all reconstitution was identical.

Freeze-dehydration is the only completely satisfactory process that has been developed for the dehydration of meat. Meat dried by this method retains its original volume and form without case hardening, provided the undried portion remains frozen throughout the drying process. If the meat remains frozen throughout the drying process, the moisture content can be reduced to less than 2 per cent without appreciable change in volume and the product has a very porous structure. This porous structure makes freeze-dehyrated meat very easy to rehydrate.

With raw meats the low temperature used during freeze-dehydrating inhibits denaturization of the muscle proteins, myosin, and actomyosin; this makes it possible to reconstitute the muscle fibers so the rehydrated product more nearly resembles fresh meat.

Some heat must be supplied to the product during the freeze-drying operation to provide sufficient energy for sublimation of the ice to water vapor. The same amount of energy must be supplied as is required to go from the solid to the liquid to the gas state. Sufficient heat should be added to obtain the maximum rate of dehydration without raising the temperature of the product high enough to permit thawing which will result in case

hardening and incomplete dehydration. The heat is supplied by a plate type heat exchanger through which warm water is circulated. A number of these heat exchangers stacked one above the other within the drying cabinet serves as shelves for the trays of frozen meat which is to be dehydrated. Experience has shown that plate temperatures as high as 110° F. can be used when the meat is frozen prior to starting the dehydration process, and when the dehydrator is operated at a maximum pressure no higher than 1.0 to 1.5 mm. of mercury. Rapid sublimation of moisture at the start of the process cools the product sufficiently to prevent thawing, then, as drying proceeds, the poor heating exchange co-efficient of the already dried portion on the outside surface protects the frozen interior section.

**Curing.**—The salting of meats was done primarily to preserve them. Long before the development of the meat packing industry, meats were treated with salt solutions or packed in salt to keep them from spoiling so that they might be held for use at a later date. It was the common practice to salt meat produced during cold weather to hold it over for use in the warmer seasons. This salting of meat continued as an important practice with the development of trade, since it enabled the meat to be shipped from an area of production to an area of consumption without deterioration.

The consumer has developed a taste for salted meat and the modern meat curing practices of the meat packing industry are aimed more at supplying the consumer with a product to satisfy his taste than a meat that has been salted for its preservation. The materials commonly used in the curing of meats are salt, sugar, sodium nitrate, potassium nitrate, sodium nitrite, and, sometimes, spices.

Modern methods of curing ham provide very little opportunity for bacteria to play a role in the curing process. The short-term curing period in general practice does not allow extensive bacterial growth in or on the surface of the hams or in the cover pickle. In addition, the heat from smoking further decreases the already negligible numbers of bacteria present. This does not rule out the possibility, however, that certain bacteria may be employed in the improvement of flavor, acceptability, and keeping qualities of ham. But a process differing substantially from the short-term cure would have to be used.

**Sweet Pickle Cure.**—There are two general types of sweet pickle cure: long cure and short or fast cure. The short cure usually employs the process of pumping the pickle into the arterial system of the meat cut or injecting the pickle deep into the meat cut at many points.

A solution of salt is the basis of all pickle and the first step consists of making up a 100° salometer strength solution of salt and then diluting it to whatever strength of pickle may be desired for the cure. Usually a 70° pickle is used in the sweet pickle cure. To this is added the sugar and nitrate and/or nitrite which are dissolved previously in water in a separate container in order to insure complete solution of these ingredients in the pickle. The temperature of the finished pickle is brought down to 36°F. Before bringing the temperature of the pickle to 36°F., some packers heat the pumping pickle to 180°F. for twenty minutes in order to destroy any bacteria which might have contaminated the ingredients.

It is customary to use one formula for the pickle which is to be injected

or pumped into the body or the arterial system of the meat cut and another formula for the pickle in which the meat cut is submerged or covered. Following are formulas commonly used in the sweet pickle curing of meats:

| | *Pump Pickle* | *Cover Pickle* |
|---|---|---|
| TYPICAL NITRATE CURE FOR HAMS | | |
| Sodium nitrate per 100 gals. | 8 lbs. | 4 lbs. |
| Sugar (wh. gran.) " " " | 20 lbs. | 10 lbs. |
| Salometer—finished pickle | 90° | 75° |
| TYPICAL NITRITE CURE FOR HAMS | | |
| Nitrite of Soda per 100 gals. | 24 oz. | 16 oz. |
| Sugar (wh. gran.) " " " | 20 lbs. | 10 lbs. |
| Salometer—finished pickle | 90° | 75° |
| TYPICAL MIXED CURE | | |
| Nitrite of Soda per 100 gals. | 1¼ lbs. | 1 lb. |
| Sodium nitrate " " " | 1 lb. | 2 lbs. |
| Sugar " " " | 20 lbs. | 10 lbs |
| Salometer—finished pickle | 90° | 70° |

The inside temperature of meat intended to be cured should not exceed 38°F. Furthermore, temperatures much lower than 38°F. greatly retard the cure.

Whether the meat cut is to be long or short cured the first process to which it is subjected is the injection of curing solution into the body of the product. There are a few packers who do not inject pickle into meat cuts that are intended to be given the long cure. Injecting the pickle into the meat speeds up the cure and since it hastens the penetration of the salt throughout the article, it reduces the incidence of deteriorative changes in the center of the product.

The pickle is injected into long cure hams at various points. For this type of cure the amount of pickle injected at each point varies from 2 to 4 ozs., with 3 ozs. being the average.

For example, in a ham to be long cured the pickle is injected at five different points. An injection is made into the shank between the shank and the pin bone, or fibula. An injection is made just posterior to the femoro-tibial joint. Another injection is made under the pelvic bone through the obturator foramen or what is also called the hole in the aitch bone. An injection is inserted about 4½ inches in the flank side parallel with the femur, and another into the cushion of the ham from the butt end below and on the cushion side of the projection of the pelvic bone through the butt end of the ham.

Since meats are pumped to speed up the cure and minimize deteriorative changes in the meat prior to the salt penetration, the injections of pickle are inserted into those parts most subject to deterioration and those parts to which the cure penetrates most slowly from the outside.

For the rapid curing of pork hams and pork shoulder cuts, as well as cuts of beef, they are artery or spray pumped. For the artery pumping a special needle is used which is inserted into the exposed end of the artery and a definite amount of pickle usually amounting to 8 to 10 per cent of the total weight of the meat cut is forced into the arterial system. In

hams, two injections are made, one into the branch of the artery leading to the cushion of the ham and the other into the branch leading to the flank.

For spray pumping, the needle has a number of holes through which the pickle passes into the meat. The number of insertions made with this needle is much greater than when pickle is pumped into hams for a long cure.

Spray pumping requires greater care in its application than does artery pumping to obtain a uniform distribution of the cure in the meat. In the case of artery pumping, the pumper must watch for ruptured blood vessels. When there is a ruptured blood vessel the meat does not swell characteristically as the pickle is injected into it.

After the meat has been pumped, it is then placed in cure. It is packed carefully in the curing container and it is then covered with pickle. At least 4½ to 5½ gallons of pickle are used for each 100 pounds of meat. When meats are to be given the long cure they are repacked 3 times. This repacking is called overhauling and consists of transferring the meats to another vat and then pouring over them the original curing pickle. The first overhaul is done five days after the meat is first put into the pickle. The second overhauling is ten days later, and the third overhauling is fifteen days after the second. A cured ham, for example is left in cure about three and one-half days for each pound of its weight.

Practice regarding the length of cure for short cured artery pumped hams, for example, varies widely. Generally, these hams are not held for more than fifteen days combining the curing and draining period and, in some cases, it is a much shorter period.

It is sometimes necessary to store cured meats for a short period after curing and before smoking. They are packed loosely and held at 36° to 38°F. if the storage period is not more than fifteen days, and at 26° to 28°F. up to thirty days.

**Plain Pickle Cure.**—A plain salt pickle is used that contains no sugar and, in some cases, no nitrates or nitrites. Bean pork is commonly cured in plain salt pickle containing no sugar, nitrates, or nitrites, however, sodium nitrate is sometimes used. Approximately 190 pounds of the pork is placed in a barrel after first covering the bottom of the barrel with about 20 pounds of coarse salt. After the pork is placed in the barrel another 20 pounds of coarse salt is spread over the top of the pork. This coarse salt is called capping salt and gets its name from this pactice of using it to cover or cap-off the meat after it is packed in the barrel. After the bean pork is packed in the barrel with the capping salt, the barrel is filled with 100° brine. Usually 5 to 5½ gallons of 100° brine is used to each 100 pounds of meat. When bean pork is packed in a barrel in this manner for curing, a common practice is to enclose the pork in a muslin sack which separates it from the coarse salt at both ends of the barrel.

Barreled fat backs for export are commonly cured with plain 100° salt pickle that contains no sugar, nitrate, or nitrite. Generally, the fat backs are first placed in vats and covered with the 100° brine. As the fat backs are placed in the vat fine salt is sprinkled on them between each layer. The fat backs are overhauled at the end of five days and again after another

five days. When they are ready for shipment the fat backs are placed in barrels with 20 pounds of coarse salt covering the bottom of each barrel. Approximately 290 pounds of fat backs are placed in each barrel and 20 pounds of capping salt is placed on top of the fat backs. The barrel is then filled with 100° brine and closed for shipment.

Spareribs are commonly cured in plain pickle to which nitrate is added. Two hundred and sixty pounds of meat are packed in a tierce with a mixture of salt and nitrate in the proportion of 10 pounds of fine salt to 12 ounces of saltpeter sprinkled over the spareribs as they are packed in layers. The tierce full of spareribs is then filled with 100° brine. The tierce is then covered tightly and after six days it is rolled vigorously to effect an overhauling of its contents.

**Dry Cure.**—*Fancy dry cure.*—This is the method usually used in the curing of bacon. The pork bellies are rubbed on all sides with the dry cure mixture and placed in boxes with the curing resulting from the moisture in the meat dissolving the curing ingredients which then penetrate into the interior of the bellies.

Following are typical formulas for dry curing.

*Nitrate Cure*

3 lbs. fine granulated salt
$2\frac{1}{4}$ lbs. granulated cane sugar
4 ozs. sodium nitrate

*Nitrite Cure*

3 lbs. salt
$2\frac{1}{4}$ lbs. sugar
0.5 to 0.75 ozs. nitrite of soda

*Mixed Cure*

3 lbs. salt
$2\frac{1}{4}$ lbs. cane sugar
$\frac{1}{4}$ oz. nitrite of soda
2 ozs. sodium nitrate

Five pounds of the mixture are used for every 100 pounds of bellies.

The ingredients of the particular dry curing formula are mixed with a high degree of care to assure their uniform dispersal throughout the mixture. This is particularly important with respect to the nitrite ingredient.

The pork bellies are packed in tight boxes made of galvanized iron or stainless steel. Frequently the boxes are lined with heavy waxed paper. Before packing the bellies in the curing box its bottom is covered with a light sprinkle of the curing mixture. Each cut is rubbed thoroughly with the curing mixture and placed in the box meat side up. The bellies are packed in tightly and each layer is sprinkled with the curing mixture. The amount of curing mixture is weighed out separately for each box and the experienced operator will so gauge his packing that there will be an equal distribution of the mixture throughout the box and at the same time just enough left to cover the top layer. The top layer is placed skin side up. An effort is made to so pack each box as to leave no empty spaces

since otherwise the pickle formed by the meat juices may not be sufficient to cover the meat. Any large space left in the box after packing due to uneven sizes of bellies may be filled in with briskets or jowls. After the box has been packed the lid is clamped down tightly so that the pickle resulting from a solution of the curing ingredients in the meat juices will cover the meat. The bellies are not removed from the box until the end of the curing period which is generally three days for each pound weight of the average belly in the container.

*Semi-Dry Cure.*—This method is also used in curing pork bellies in the preparation of bacon. It differs from the dry cure method in that 40° pickle is used to cover the bellies after they are packed in the box. On account of the added pickle the salt in the dry cure formula is cut down ½ pound for each 100 pounds of meat to be cured.

*Dry Cured Hams.*—With the exception of Italian style ham, dry curing of hams is no longer generally conducted by the meat packer in the United States. The dry curing mixture is rubbed over the surface of each ham and they are piled closely together skin side down in layers with a layer of the dry curing mixture between each layer of hams. This stack of hams is then covered with heavy paper to protect the meat from circulation of air. The hams are overhauled after five days, fifteen days, and thirty days and are re-rubbed with the curing mixture at each overhauling. The total time in cure ranges from forty days to sixty-five days depending on the weight of the hams. The pelvic bone is removed from the Italian style ham before it is cured. This enables the ham to be pressed flat to a thickness of about 2 inches.

A modification of the dry cure method of treating pork bellies provides for the multiple punching of holes into the belly. This permits rapid penetration of the dry curing salts. During the curing a temperature somewhat higher than normally used (48° to 50° F.) permits the punctured bellies cured by this system to have completed the cure in about three days.

*Dry Salt Cure.*—This method of cure results in a high salt content in the finished cured product and was commonly employed in curing many classes of meat cuts for export. It is still used quite widely for pork fat backs and also occasionally for pork jowls and heavy pork bellies.

Fat backs are commonly stacked 3 to 3½ feet high using 7 to 8 per cent salt. The first overhauling is made after eight to ten days in cure when the fat backs are restacked as high as 4 feet. Approximately 5 per cent of salt is used when the fat backs are restacked at the first overhauling. For the heavier fat backs there is a second overhauling at the end of the twentieth day. The total curing time required for fat backs ranges from twenty to thirty days depending on their size. Dry salt fat backs frequently develop a pinkish color if held in cure over fifty-five days.

Before pork jowls are put down in salt they are soaked in 100° plain pickle for three to five days. After draining they are thoroughly salted and piled in stacks to complete the cure. Usually 6 to 7 pounds of salt are used to each 100 pounds of pork jowls. The jowls do not require overhauling and they cure in fifteen days.

Pork bellies to be dry salt cured are usually pumped with 100° pickle containing 10 pounds of saltpeter per 100 gallons of pickle. After being

pumped they are salted thoroughly with 6 to 7 per cent of salt and piled in stacks. They are overhauled and pumped again after eight to ten days in cure. The usual curing period requires one day for each pound weight of each belly. It is not unusual for bellies to be soaked in pickle for a few days before being packed in dry salt.

Attention is given to the product exposed along the sides of the pack during the dry salt curing process to make sure that the exposed product is well salted.

*Injecto-crue.*—A machine has been designed to pump curing solution into a pork belly through 100 needles. The machine automatically conveys the belly to the injection position. It charges the pickle injector, elevates the belly into position, injects the pickle into the belly, strips the belly from the needles, and discharges it from the unit. One such mahcine can handle approximately 100 tons of pork bellies per week. The curing time required after injection is two days as compared to two or three weeks for the older methods. The palatability and keeping time of bacon prepared by the so-called injecto-cure method are not significantly different than for bacon that is otherwise cured.

When this method of pumping bellies was first started, the needles used were $\frac{3}{32}$ of an inch in diameter. These had a tendency to bend and break. This usually happened when pumping unskinned bellies or bellies that were too solid from chilling.

The needles were then increased to $\frac{4}{32}$ of an inch in diameter and the bellies skinned before pumping. This has practically eliminated the bending or breaking of the needles.

The needles used are 3 inches in length. If the needles do break, it is usually at the collar and the needles being as long as they are, the end of the needle is up above the belly and is easily seen by the person taking the pumped bellies away from the machine. Then, as an extra precaution, after running two or three loads of bellies, the machine is stopped and the needles are examined to see if any are bent or broken.

If any should be found broken, the loads of bellies last run are examined until the needles are found.

**Curing Ingredients.**—Although any good commercial grade of salt is satisfactory for curing meats, the physical condition of the salt is of considerable importance. A salt that dissolves readily is desirable in the preparation of pickle solutions since, usually, the pickle is prepared by percolation without agitation. Flake salt is preferred for dry cure mixtures because it lends itself to uniform distribution of the curing materials in the mixture and a more uniform application to the meat. Rock salt commonly contains impurities such as shale which is not soluble in water. This is also true of other classes of salt and for this reason recrystallized salt is considered to be best for curing purposes when it comes directly in contact with the meat. Recrystallized salt is the salt prepared by dissolving in water the salt as it is removed from the mine or salt beds, settling and filtering out the impurities, and crystallizing the salt out of the solution by evaporation.

Flavor in cured meats is a factor of greater importance in recent years than the preservation of meats by curing. This is particularly true in meats prepared by the sweet pickling method of curing and in bacon prepared

by the fancy dry cure method. The use of salt in these curing processes, therefore, is adjusted to obtaining a particular flavor in the cured product rather than using it in concentrations that would accomplish a stablizing effect against deterioration of the cured product. Refrigeration is therefore still relied on to protect these classes of cured meats. Sugar as well as salt contribute to the flavor. The salt, of course, is the predominant flavor. The flavor contributed by the sugar in the curing formula is two-fold. It furnishes a favorable medium for the growth of flavor-producing bacteria as well as its normal sweetening effect. Although nitrate and nitrite are used primarily to fix the color of the cured meat, a characteristic flavor results from the action of the nitrite on the muscle tissue.

The curing process changes the chemical nature of meat pigment. This accounts for the difference in appearance between cured meats and fresh meats, particularly the retention by cured meats of a bright red color when they are cooked. It was once thought that the pigment of meat was identical with blood pigment and that the bright red color of cured meat resulted from the color fixation of blood pigment. Actually, the slaughter of animals includes a process of bleeding that removes most of the blood from the carcasses. Determinations of amount of muscle hemoglobin or myoglobin by Schenk, Hall, and King (1934), and by Watson (1935), occurring in the muscle tissue obtained from the carcasses of several animals indicate that this pigment comprises nearly all of the tissue pigment. The pigments of cured meats, therefore, are nitric oxide myoglobin, and nitric oxide myochromogen. The nitric oxide or, more properly, nitrous acid, since the pH of meat is normally on the acid side, is derived from nitrite. The nitrite is either added to the meat as *such as part of the curing mixture or is derived from the* nitrate which is reduced through mycrobial action. The nitric oxide myoglobin is the first pigment produced in the cured meat and this is converted by heat into nitric oxide myochromogen, a denatured protein.

The maximum amounts of sodium nitrite and/or potassium nitrite which may be used are as follows:

(1) 2 pounds in 100 gallons of pickle.
(2) 1 ounce for each 100 pounds of meat in dry salt, dry cure, or box cure.
(3) $\frac{1}{4}$ ounce in 100 pounds of chopped meat and/or meat byproducts.

**Smoking.**—Like curing meat with salt, the practice of subjecting meat to wood smoke goes back to pre-historic times. Modern practices of smoking meats differ from ancient practices principally in that formerly considerable drying out of the meat during the smoking process was accomplished. This drying out of the smoked meat contributed to its keeping qualities, however, the bactericidal action of the products of the wood smoke that are deposited on the meat inhibits the development of spoilage organisms and the antioxidant effect of some of these wood smoke products retards the development of rancidity in the fat. Like curing, the smoking of meats imparts a taste to the product for which the consumer has developed a decided preference. Modern smoking methods which are conducted under controlled conditions of temperature and humidity accomplish an optimum smoke flavor in the product with a minimum of drying out of the product, gaining at the same time the bactericidal and antioxidant effects of the products of the wood smoke which are deposited on the meat and fat.

The old method of firing the smokehouse is the obvious one of building a fire of hardwood in the pit of the smokehouse. This produced the heat and smoke to which the meats hung in the smokehouse were subjected. Frequently, the fire was smudged with sawdust to increase the volume of smoke. Sometimes several fires would be built in an effort to distribute the heat and smoke uniformly throughout the smokehouse. In recognition of the need for uniform distribution of heat throughout the smokehouse and a more controlled volume of smoke, heating devices are installed in smokehouses and the smudging of the sawdust is regulated. Charcoal burners and steam coils are examples of devices that are installed in smokehouses to provide a uniform and regulated heat. Sawdust is smudged by means of controlled currents of air or by applying gas or oil flames to the sawdust. Where oil is used care is exercised to produce a flame with perfect combustion so as to avoid oily soot which may be deposited on the meat. Smoke generators located outside of the smokehouse have also come into use. These lend themselves to effective control and the smoke is carried in ducts from the generator to the smokehouse where the meat is hung.

Hickory sawdust is preferred by most packers for smoking meats. As a practical matter sawdust derived exclusively from any particular wood is not generally available commercially with the result that sawdust from a variety of hardwoods is usually used. In addition to hickory, sawdust derived from oak, maple, birch and beech is used with good results—with that derived from the seasoned wood being preferred. Walnut is said to give a quick color to meats but the flavor that its smoke imparts to meats is considered by some to be undesirable. The soft woods are avoided since their smoke also imparts an unpleasant taste to the meat.

In work done by Pettet and Lane in 1940 on the chemical composition of woodsmoke, they extracted with methylene dichloride the condensates of woodsmoke and found them to consist of formaldehyde, acetaldehyde, furfuraldehyde, 5-methyl furfuraldehyde, acetone, diacetyl, methyl and ethyl alcohols, phenol, formic and acetic acids, resins, and wax. All woodsmokes appear to contain less of the aldehydes, phenols, and aliphatic acids than the product of destructive distillation of wood. The preservative action of woodsmoke on meat is considered to be due to the condensates consisting of aldehydes, phenols, and aliphatic acids.

The Canadian workers, White, Gibbons, Woodcock and Cook, in 1942 made bacteriological, chemical, and physical examinations on smoked and unsmoked Wiltshire bacon. They observed that smoking reduced the number of surface bacteria approximately 10 to 4 times the number present before smoking and effectively retarded growth during storage. They also found smoked bacon to be more resistant to rancidity than unsmoked bacon. This confirms Lee's observations in 1939 that smoke enables surface fat of bacon to resist oxidation for considerable periods of time.

Meats that have been subjected to the long curing process are smoked at lower temperatures than the quickly cured artery or spray-pumped meats. The cured meats that are to be smoked at lower temperatures are first permitted to dry either in a hanging room provided for the purpose or during the initial period in the smokehouse. After they have dried, the meats in the smokehouse are subjected to rapidly rising temperatures

which reach 135°F. This temperature is maintained in the smokehouse until the interior temperature of the meat has reached at least 110°F. The characteristic color of smoked meats is more permanently set and heightened if the meat is smoked to a degree that raises the internal temperature to approximately 118°F.

After the period of smoking at a high temperature, known as the "hot smoke", the temperature of the smokehouse is lowered to approximately 120°F., where it is held throughout the remainder of the smoking operation. During this period, the smokehouse ventilators are closed or nearly closed in order to produce a thick and heavy smoke cloud throughout the smokehouse.

Care is exercised to see that the internal temperature of the pork products smoked according to the foregoing description of processing does not rise to the point where the meat acquires a cooked appearance which may occur at around 120°F. The further heating of such pork to reach an internal temperature of at least 137°F. is necessary for the destruction of possible live trichinæ since pork having a cooked appearance may be eaten without further cooking.

The artery- or spray-pumped cured meats are subjected to a process of heating in the smokehouse for the production of "tendered" and ready-to-eat smoked meats. This process consists of subjecting the meats to relatively high temperatures for extended periods of time which accomplishes tenderness in the product and raises the temperature of the pork above the 137°F. necessary for the destruction of possible live trichinæ. The usual practice is to reach an internal temperature of about 140°F. for the "tendered" product which is intended to be further cooked by the consumer before serving. The ready-to-eat smoked meats are heated to internal temperatures ranging from 150°F. to as high as 165°F.

The "tendered" and ready-to-eat smoked meats are more perishable than other types of smoked meats and are handled the same as a cooked product. They are transferred directly from the smokehouse into a refrigerated hanging room, held at a temperature close to 40°F. These products are chilled promptly so that the meat will pass quickly through the critical temperature range from 75°F. to 105°F. The mild cure of this class of product will not protect it against spoilage under favorable conditions of bacterial growth.

Smoking imparts a desirable appearance to the surface of the meat through a combination of actions. Through its drying out effect and the action by the aldehyde-phenol condensed resins on the film of grease that develops on the dried out surface, there is accomplished the gloss which is the characteristic appearance of the surface of smoked meats.

During the smoking process the reduction of nitrate to nitrite is inhibited and the amount of nitrite in the meat at the beginning of the smoking operation is reduced sharply during the heating of the meat in the smokehouse. The disappearance of the nitrite is explained as occurring because of the reaction between the nitrite and the aliphatic amino group of the protein. High temperature is the factor responsible for the destruction of nitrite in the meat during the smoking process. Jensen is of the opinion that in addition to the reaction on the nitrite by the amino groups of the

protein, oxidation of the nitrous acid, especially on the surface area of the meat, accounts for part of the reduction of the nitrite content during the smoking of the meat.

There is no change in the nitrate content of the meat during the smoking process and when present in the meat it carries over to produce more nitrite by the usual process of reduction following the cooling of the meat after it is smoked.

Although the products of smoke that are deposited on the meat have a strong bactericidal action, they do not have a comparable inhibitive effect on mold growth. The residual aldehydes from smoke are not especially effective as mycostats according to Jensen (1945). Furthermore, the curing agents are not particularly effective against mold growth. Mold, therefore, grows readily on smoked meats when the conditions for its growth are favorable. For this reason it is important to maintain the surface of smoked meats as dry as possible. Smoked meats are handled in such a way as to avoid the condensation of moisture on their surface and they are not exposed to humid atmospheric conditions.

A smoking process has been developed that rapidly deposits the smoke particles out of an atmosphere of smoke on meat by what is referred to as an electrostatic method. By this method meat can be smoked in a matter of minutes as, for example, a pork belly is smoked to a normal flavor level in two and one-half to three minutes.

Smoke from a generator enters near the bottom of the chamber through a duct and passes upward past wire ionizers which flank the meat intended to be smoked. Each bank of ionizers is connected by means of an electric cable to a high voltage source located outside the chamber. The ionizer potentials range from 25,000 to 35,000 volts and the ionizer wires are banked about 16 inches apart so that no portion of the product comes close enough to the ionizer wire to produce an arc.

The surface appearance of product smoked by this method does not resemble the effect produced by the conventional smoking. This can be corrected by following the electrostatic smoking with a heat treatment. This heating stabilizes the deposited smoke on the surface of the product. At least one installation uses an infrared heating chamber for this purpose.

**High-frequency Cooking.**—High-frequency cooking is sometimes called dielectric heating process. In this process the product to be cooked is placed between two plates or poles. These plates are charged with a high voltage, very rapidly alternating electric current. Polar molecules of the product having positive and negative ends attempt to keep in alignment with the rapidly alternating positive-negative charge at the plates and in so doing release energy in the form of heat. The product is literally forced to heat itself and every part is heated at the same time and at essentially the same rate.

In contrast to the conventional cooking by heat which requires applying heat to the outside of the product for a long enough period to permit the center to reach a desired processing temperature, the major attraction of applying high-frequency dielectric heating to the production of processed meats lies in uniformity and rapidity of heat processing.

Some practical difficulties have been encountered in applying this to

practical production procedures. While there apparently is little or no direct flow of current between the plates and through the product being heated, thus far it has been found necessary to have the product in direct contact with both plates. This poses some difficulty in practical application. In line production, for example, it would be logical to use a mechanical conveyor to carry the product through the processing unit. Plate contact requirements, however, would require intermittent halting of the conveyor and the use of some device to bring the plates into direct contact with the product. Furthermore, the plates must come into direct contact with the product itself and cannot be separated from it by tinplate as would be the case in applying this method of processing to canned product. The successful application of the high frequency process depends on designing a processing unit that will assure the uniform application of the process to all parts of the meat to be treated.

**Vinegar Pickled Meats.—Pigs Feet.**—Two methods of curing and processing are used in preparing vinegar pickled pigs feet. The conventional long curing method conducted in the curing cellar uses an 80° to 100° salometer brine with added nitrite and nitrate. The curing period extends from eight days to two weeks. Discoloration of the pigs feet may occur when held too long in the curing cellar.

After curing, the skin is cut from toes to shank and the feet are cooked in hot water until the desired tenderness is achieved. The feet are then well cooled in running water and removed for thorough chilling in the refrigerator. The chilled feet are split and semi-boned.

The feet are then pickled in bulk overnight in approximately 45 grain vinegar and washed and packed in jars with a more dilute vinegar, or, they may be packed directly into jars which are then filled with 45 grain or stronger vinegar. Usually bay leaves, pepper, and spices are added for appearance and flavoring.

The other procedure for processing pigs feet is called the "hot curing" method. The feet are cured as they are cooked. Although considerably more rapid, this method requires more attention to prevent nitrite burning and other types of discoloration. The nitrite content of the cooking brine must be reduced drastically.

The usual procedure is to hold the chilled pigs feet several hours in cold curing brine before the "hot curing" process. The temperature is then raised gradually to 180° to 185° F. until they are cooked to desired tenderness. The feet are then thoroughly cooled by running water as an essential step in removal of any excess nitrite and to prevent bacterial spoilage before vinegar pickling.

**Sausages.**—Sausages to be used for vinegar pickling are prepared in the conventional manner. Care is exercised during their preparation to assure that the internal temperature of at least 155° F. is reached so that the interior of the sausages will not be the source of acid-tolerant microorganisms.

As soon as possible after the sausages have been smoked and chilled, they are packed in vinegar. The vinegar concentration is maintained as high as is possible consistent with accomplishing a desirable flavor in the product. A minimum concentration of 3.6 per cent acetic acid has been

identified as being necessary to prevent bacterial spoilage in vinegar pickled products.

It is important that the proper concentration of vinegar remains in the pickle after equilibrium has been established with the sausages. To achieve a residual 36 grain vinegar in the pickle, it is necessary to pack the sausages in a probable 70 grain vinegar.

The presence of sugar may create problems in the vinegar pickling of sausage. It is considered good practice, therefore, to eliminate sugar from the sausage formulation. For example, turbidity development due to microbial growth in the pickled products is rarely observed unless sugar is added in the processing of the product or to the vinegar pickle.

Vinegar pickled sausage is sometimes pasteurized to give it additional stability. The spoilage microorganisms are not very heat resistant and a temperature of 150° F. for fifteen minutes or an equivalent processing is regarded as being sufficient.

Nitrite is used as one of the curing agents for both pickled pigs feet and pickled sausages to achieve the desired pink color. Nitrite is the salt of a hypothetical weak acid, nitrous acid.

This acid and some of its decomposition products are highly reactive substances. It is a powerful oxidizing agent and may react with many constituents of meat. As the acidity is increased, nitrite becomes more reactive and thereby less stable. The consequences of this high reactivity may make itself felt on the finished vinegar pickled products. The product is subject to nitrite burns upon adding vinegar just as though considerably more nitrite than the allowable limit had been added to the original product.

A familiar consequence of too much nitrite added to meats is the brownish or greenish discoloration of the muscle pigment. Nitrite, especially when acidified, may also react with meat constituents causing the chemical alteration of amino acids with the production of gaseous nitrogen as one end-product.

**Sausage Room Products.—1. Sausage.**—The practice of stuffing salted chopped meat flavored with spices in animal casings is an ancient custom. It can be visualized as developing logically in connection with the economic utilization of all the edible portions of the carcasses of food animals. There are records of sausage being a popular item of food during the Grecian and Roman eras, and independently of the European practices, the American Indian is known to have prepared a rudimentary sausage consisting of chopped dried meat mixed with dried berries and pressed into a cake.

By the Middle Ages, sausage making was extensively practiced on a commercial scale in many localities throughout Europe. Out of these practices developed types of sausage characteristic of certain localities. For example, Frankfurt-on-Main in Germany developed the popular frankfurter, bologna is said to have originated in Bologna, Italy, genoa salami in Genoa, Italy, berliner in Berlin, Germany, braunschweiger in Brunswick, Germany, gottborg in Gothenberg, Sweden, wieners in Vienna, Austria, etc. Dry sausages as a class were developed in the warm sections of Italy and Southern France. In the colder climate of Northern Europe the fresh, semi-dry, and smoked and cooked varieties of sausage were developed Although types of dry sausage were produced in the colder

climates of Europe and fresh sausage was actually used in the warmer climates, classes of sausage products as developed in various areas were influenced by climatic conditions since artificial refrigeration was unknown.

With the exception of bulk fresh sausage which sometimes is not merchandised in casings, sausage products are universally prepared in casings. Originally, these casings were of animal origin but in recent years so-called artificial casings made from hydro-cellulose and plastic materials have become very popular.

**Animal Casings.**—ROUNDS.—The term "round" refers to the animal casing derived from the small intestines of cattle, calves, sheep, and hogs. The small intestines of sheep and hogs are separated from their mesenteric attachments by pulling which frees them entirely from the fat and tissue at their attachments. The small intestines of cattle and calves are severed from their mesenteric attachments by a process of cutting called "running." This leaves attached to the severed intestine some fat and tissue derived from its mesenteric attachment. In any case, the intestine is stripped clean of its contents and the superficial fat adhering to the intestines of cattle and calves is also removed. The cleaned intestines are chilled, drained, and salted. The cattle rounds are graded according to their diameter as narrow, medium, and wide. The narrow grades are usually $1\frac{3}{8}$ of an inch or less in diameter, the medium grades are $1\frac{3}{8}$ of an inch to $1\frac{1}{2}$ of an inch in diameter, and the wide grades over $1\frac{1}{2}$ of an inch in diameter. The sheep rounds are classified in five grades according to their diameter: narrow, narrow medium, special medium, wide, and extra wide. The narrow grade ranges from 16 to 18 mm. in diameter, the narrow medium 18 to 20 mm., special medium 20 to 22 mm., wide 22 to 24 mm., and extra wide 24 to 26 mm. Hog rounds are usually placed in three grades: narrow, medium, and wide. The narrow grade measures up to $1\frac{1}{8}$ of an inch in diameter, medium measures $1\frac{1}{8}$ of an inch to $1\frac{3}{8}$ of an inch in diameter, and the wide over $1\frac{3}{8}$ of an inch in diameter.

MIDDLES.—These are derived from the large intestines of cattle and hogs. They are removed from their mesenteric attachment by a combination of cutting and pulling which leaves some of the mesenteric fat attached to the severed intestine. The intestines are thoroughly flushed free of their contents and the excess fat is removed. The fat is removed from the intestines of cattle by first chipping it off manually using knives or scissors, after which the intestines are passed through fatting machines. After being fatted the intestines are turned inside out and sent through a sliming machine which thoroughly cleans their mucous surface. The cleaned intestines are then chilled in cold water and later drained and salted. The hog middles usually measure approximately 7 feet in length and vary considerably in diameter. The cattle middles, or, as they are usually designated, the beef middles are packed in sets measuring not less than 57 feet consisting of 5 pieces to the set and they are classed as "wide" running 2 inches and over in diameter and "narrow" under 2 inches.

BUNGS.—The bung derived from cattle is called the beef bung and is made from the cecum. This casing is sometimes called the "blind gut." It is handled substantially the same as the beef middle. The beef bung

ranges from 18 to 36 inches in length which is determined by the location of the ileocecal valve.

The hog bung is the terminal end of the intestinal tract of hogs, the desirable length being at least 5 feet. After it is separated from the rest of the viscera, the bung gut is stripped of its contents and trimmed of its excess fat. The anal end of the hog bung is called the "crown." After the fat is trimmed the bung is inflated with air, measured for width, and inspected for grade. The width is measured by inserting the inflated bung into a gauge at a point 18 to 20 inches from the crown. The better grades of bungs are full crowned, free from cuts and stains, and the larger sizes are preferred. After being graded, the hog bungs are turned inside out and are chilled in cold water before being salted.

Sewed Casings.—Beef middles and small hog bungs are used for making sewed casings of a uniform diameter. The middles and bungs are stretched on flat wooden forms and are hung up to dry in a circulation of air. After these casings have sufficiently dried they are cut along a groove in one edge of the wooden form. The pieces are then flattened out and sewed together to make a casing with one end closed and of a uniform diameter.

Bladders.—The urinary bladders of hogs and cattle are used in preparing this class of animal casing. They are cleaned thoroughly after which they are either packed in salt or inflated with air and dried. After being thoroughly dried they are then softened in an atmosphere of steam in the drying room. In this softened condition they are removed from the drying room and flattened out for tying in bundles, after which they are packed in boxes for shipment or taken directly to the sausage department.

Weasands.—The cattle esophagus from which the weasand is manufactured consists of two portions—the muscular coat and the mucosa. These are easily separated from each other. The muscular coat is edible muscle tissue which is commonly used in sausage manufacture. The mucosa is made into the casing known as the weasand. The mucosa is first inspected for the larval form of the hypoderma lineata and all infested portions are removed and discarded. The parasite-free mucosa is inflated with air, tied off at both ends and hung up to dry. After drying, one end of the weasand is cut off at the point where it is tied and the weasand is ready for shipment from the plant or for use as a casing in sausage manufacture.

Hog Stomachs.—When the hog stomach is intended for use as a container for sausage it is not slit wide open as is done when the stomach is prepared for use as an ingredient of a meat food product. It is saved intact and flushed of its contents. It is then turned inside out and the mucous surface is thoroughly cleaned. After being cleaned the stomach is chilled and salted. The stomachs are first placed in salt in a perforated container which permits drainage of the liquids produced by the action of the salt on the stomachs. The following day the stomachs are re-packed in salt where they are left until thoroughly cured.

**Artificial Casings.**—Since about 1920, casings of hydrocellulose material have been made in sizes and shapes resembling animal casings. This class of casings is sometimes referred to as "artificial casings" by contrast with the term "natural" casings for the casings of animal origin. The artificial

casings are both transparent and translucent. They are permeable and compare quite favorably in strength with the animal variety. The hydrocellulose material used in the preparation of artificial casings tends to become brittle and for this reason it is impregnated with hydroscopic softening agents. The casings are moistened at the time they are used as containers for sausage products since this gives them pliability and facilitates their handling. This wetting, however, tends to dissolve out the hydroscopic softening agent. Therefore, only those casings which are to be used promptly are moistened because casings that are permitted to dry out tend to become brittle.

There are three genreral types of artificial casings. The so-called pliofilm casing is made of a synthetic rubber modified by the addition of small amounts of harmless chemicals. The so-called saran casing is made of synthetic resins that are also modified by the addition of small amounts of harmless chemicals. The hydrocellulose casing is made of regenerated cellulose. The cellulose is obtained mostly from wood pulp and cotton linters and is plasticized by treating with alkali. The plastic mass is then neutralized with acid, washed free of chemicals, and extruded by machine in the desired form.

**Classes of Sausage.**—FRESH.—This class of sausage derives its name from the fact that the sausages are neither cured, smoked, nor cooked. Only enough water is used in their preparation to facilitate chopping of the ingredients and is limited to 3 per cent of the total of the ingredients used.

*Pork Sausage.*—As the name implies, this sausage is prepared with chopped pork and flavoring. Many flavoring combinations are used but those that include sage, pepper, and mace are the most popular. White pepper is preferred to black pepper because the latter tends to darken the product. Pork sausage is generally stuffed in sheep or hog rounds but it is also distributed in bulk—sometimes packaged in transparent wrappings in 1-pound units. When stuffed in sheep and hog rounds of the narrower sizes, the sausage is usually linked but when it is stuffed in wide hog rounds it is not linked.

*Breakfast Sausage.*—This is made from a variety of meat and meat byproduct ingredients usually with pork predominating. Dried skim milk or cereal is sometimes used as an ingredient of this class of fresh sausage and in an amount not to exceed a total of $3\frac{1}{2}$ per cent in the finished product. Breakfast sausage is prepared in bulk and in sheep and hog rounds similar to pork sausage.

*Fresh Thuringer.*—This is an all-meat sausage made predominantly of pork to which veal is added. The meat is flavored with a combination of spices, such as mace, ground caraway, ginger, pepper, ground celery seed, and coriander in addition to sugar and salt. It is stuffed in wide hog rounds and usually linked, with 3 to 5 links to the pound.

COOKED SAUSAGE.—This class of sausage is characterized by the quality imparted to the product through the addition of nitrates and/or nitrites and also through the processes of smoking and cooking. This sausage is cooked either in vats of water, steam chambers, or in the smokehouse.

The meat and meat by-product ingredients intended for use in the preparation of this class of sausage were at one time thoroughly cured

into the meat particles and act on the meat pigment before the sausage is placed in the smokehouse. During the smoking the temperature of the smokehouse is raised to over 160°F. which thoroughly heats the product, raising its temperature to the point where it is safe to eat without further cooking. The sausage receives no additional cooking to the heating it receives in the smokehouse. It is showered with cold water as it is removed from the smokehouse.

*B. Smoked Pork Sausage (Country Style).*—As the name implies, this sausage is made entirely of pork with no added ingredients except the flavorings, and nitrite or nitrate and nitrite, and water. In the southern States, smoked pork sausage is sometimes made without nitrate or nitrite. The pork is ground through a $\frac{1}{4}$ inch plate and then mixed with the other ingredients. The mixture is stuffed in a medium hog round and held for twelve hours to permit the nitrite to act on the meat before it is placed in the smokehouse. Since this sausage is classed as one that is customarily eaten without cooking, it is required to reach an internal temperature of at least 137°F. Usually this temperature is attained during the smoking operation.

*C. Berliner or New England.*—This is a characteristic, coarse-cut sausage stuffed in large casings. It is made predominantly of pork with a small percentage of beef. The meat is ground through a $\frac{3}{4}$ inch plate after which it is mixed with salt, sugar, and nitrite or nitrate and nitrite, and water. Because of the large pieces of meat, the mixture is held at a temperature of 38°F. for three or four days to permit the nitrite to penetrate the pieces of meat and act on its pigment. After this curing period, the mixture is stuffed in large artificial casings or in beef bungs or beef bladders. The product is then smoked at a temperature ranging from 120° to 145°F. after which it is cooked for four to six hours in water at a temperature of 160°F. A temperature of around 148°F. is attained throughout the product.

*D. Minced Bologna.*—This a coarsely chopped bologoa stuffed in beef bungs or artificial casings of similar size. Usually pork predominates and the flavoring materials are similar to those used in the preparation of the finely cut varieties of bologna. The ingredients are mixed and the mixture is held for three to four days to permit the nitrite to penetrate the coarsely cut particles of meat before the mixture is stuffed in the casing and placed in the smokehouse. After being smoked for several hours at temperatures ranging from 120° to 145°F. the sausage is removed from the smokehouse and cooked in water from four to six hours at a temperaturue of 160°F. A temperature close to 150°F. is attained throughout the product during the cooking operation.

*E. Salami Cotto (Cooked Salami).*—By contrast with most salami this is subjected to relatively high temperatures in the smokehouse, which produces a cooked product. It is prepared predominantly of pork with beef added. The pork is ground through a [illegible] inch plate and the beef through a [illegible] inch plate. The ground meat is mixed with salt, sugar, black pepper and nitrite or nitrate and nitrite. The mixture is held at 38°F. for at least forty-eight hours to permit the nitrite to act on the meat pigment before the mixture is stuffed in the casing. After stuffing, the product is usually held for another twenty-four hours at 38°F. and then it is placed in the

smokehouse. The heating of the salami in the smokehouse is conducted without smoke. The temperature of the salami is raised above 137°F. to make it safe for eating without further cooking.

*F. Thuringer.*—This is a cooked, smoked, coarsely chopped sausage prepared predominantly of beef to which pork is added. It is stuffed in a wide hog round. To the coarsely ground meat are added sugar, ground white pepper, whole white pepper, mustard, salt, and nitrite or nitrate and nitrite. The chopped mixture is held at 38°F. for forth-eight hours to permit the nitrite to act on the meat pigment. It is then stuffed into the wide hog round and placed in the smokehouse where it is subjected to smoke at relatively low temperatures and finished with a hot smoke during which the internal temperature of the sausage is raised above 137°F.

METTWURST.—This sausage is sometimes called "smearwurst" and is characterized by its soft spreading consistency. In this respect it differs from all other classes of sausage. It is made predominantly of pork which is chopped fine with the salt, flavoring materials, and nitrite or nitrate and nitrite. The ingredients are stuffed into a wide hog round or beef round and tied off in links 2 to 3 inches long. It is smoked at comparatively low temperatures. Since this class of sausage is customarily eaten by spreading it on bread by the consumer without any further preparation, it is necessary that the pork ingredient be treated by one of the methods to destroy possible live trichinæ. The processing of the sausage does not usually accomplish this because the smokehouse temperature is not high enough to raise the temperature of the sausage over 137°F. So-called certified pork is therefore used as an ingredient. Suck pork is identified as having been treated to destroy possible live trichinæ and this is usually done by freezing. Viable trichinæ are destroyed in pork that is frozen for twenty days at 5°F., ten days at −10°F., or six days at −20°F.

SEMI-DRY. (SOFT) (SUMMER).—The semi-dry sausages have gained increasing popularity in the United States by contrast with the dry variety. It is difficult to place certain kinds of sausages categorically in either of the two classes. Some cervelats may be either semi-dry or dry, depending on the degree of drying preferred by the trade. It has become a practice, however, to prepare most cervelats as semi-dry sausages. In addition to consumer preference for a semi-dry cervelat, another consideration is the treatment required for those containing pork to destroy possible live trichinæ. It has been found convenient to attain a temperature over 137°F. in the smokehouse to accomplish this result rather than rely on the prolonged exacting drying treatment for this purpose.

*Cervelats. Farmer and Holsteiner.*—A combination of beef and pork is used in preparing these sausages, with beef predominating. The beef is chopped separately to a medium fine texture while the pork is cut into pieces about ½ inch in thickness. The meat is then mixed thoroughly with salt, spices, and nitrite or nitrate and nitrite. This mixture is stuffed in beef middles of a medium width for the manufacture of the farmer variety while for the holsteiner variety it is stuffed in wide beef rounds. Before being stuffed in the casings, the mixture is held for from two to three days to permit the nitrite to act on the meat. After stuffing, the sausage is allowed to hang for about twelve hours before smoking. It is given a heavy

prior to their use as ingredients. A method has been developed whereby the nitrite or nitrate and nitrite is mixed intimately with the meat and meat by-product ingredients at the time they are chopped preparatory to stuffing in the casings. This method is sometimes referred to as "emulsion" cure. It derives its name from the practice of finely chopping the meat while at the same time adding a solution of the nitrite or nitrate and nitrite. This mixture is referred to as an emulsified mass. The nitrite acts immediately on the pigment of the finely chopped meat and meat by-products with which it is intimately associated. This mixture is sometimes allowed to stand at a temperature of 38°F. for twenty-four hours before it is mixed with the flavoring ingredients. Variations of this method have been developed and, in some cases, the flavoring materials are chopped in with the meat and meat by-product along with the nitrite or nitrate and nitrite and the mixture is stuffed immediately into the casings. Sometimes the stuffed product is permitted to hang for several hours before it is placed in the smokehouse.

When the coarse-chopped varieties of cooked sausage are prepared, the mixture of chopped meat and the nitrite or nitrate and nitrite is held at a temperature of 38°F. for such time as is necessary to permit the nitrite to act on the meat pigment. This may take from one to four days depending on the degree of coarseness to which the meat ingredient is chopped. It is essential that the conversion of the myoglobin of the meat by the nitrite to nitroso myoglobin be complete before the sausage is submitted to the smoking or heating processes. The nitroso myoglobin formed by the action of the nitrite on the pigment of the meat and meat by-products is converted into nitroso myochromogen during the smoking and cooking. To facilitate chopping and blending of the ingredients and to impart a juiciness to the finished article, water is a substantial ingredient of cooked sausage. However, its use is limited to that amount which will result in the finished product containing not more than 10 per cent added water.

When the casing is to be colored as part of the processing of the sausage product, the coloring material is usually added to the water in the tank in which the sausage is cooked.

*Finely Chopped Sausage.—A. Frankfurters and Wieners.*—These names are used in different parts of the country to identify the same product. They are prepared with a wide variety of meat and meat by-product ingredients. Also, dried skim milk, cereal, or soya flour is used in an amount which individually or collectively does not exceed a total of 3½ per cent in the finished product. A formula consisting of three parts of bull meat or beef chucks to two parts of pork trimmings is considered to produce the best quality product. A great variety of flavoring materials is used, however, a combination of white pepper, coriander, and nutmeg or mace is probably the most popular.

The ingredients are stuffed in sheep or hog rounds or in hydrocellulose casings of comparable size. The length of the links varies between different sections of the country. The stuffed product is placed in a smokehouse in which the temperature is usually raised to 160°F. By this method the frankfurters are heated thoroughly at the same time that they are smoked. They reach an internal temperature well over the 137°F. which is required

to destroy possible live trichina in the pork muscle tissue. This makes them safe for eating without further cooking. In some cases the cooking of the frankfurter is completed in a vat of water ranging in temperature from 165° to 170°F. This cooking is usually limited to from seven to ten minutes.

*B. Bologna.*—This is prepared in "long", "large", and "round" varieties Long bologna is stuffed in beef middles approximately 18 inches long or in corresponding artificial casings. Large bologna is stuffed in beef bungs approximately 18 inches long. Round bologna is stuffed in beef rounds or the corresponding size of artificial casings, usually 16 inches long. The same mixture of ingredients that is used in the preparation of frankfurters and wieners is generally used in preparing bologna. The method of processing is also quite similar except that the bologna usually receives its thorough cooking in a vat of hot water following the smoking operation. Cooking of the bologna is conducted at such temperature and for a period of time sufficient to reach a temperature of 137°F. throughout the product. This is another class of sausage product that is customarily eaten without cooking and this temperature is necessary to destroy possible live trichinæ. Actually, an internal temperature of 150°F. is usually attained throughout the bologna at the time it is cooked.

*C. Knackwurst.*—This class of sausage is made from the same ingredient combinations as are used in the preparation of frankfurters, wieners, and bologna, except that there is no dried skim milk, cereal, or soya flour added. The product is characterized by its large size and short links, being stuffed in a beef round and tied off in 4-inch links. It is usually flavored with garlic which also is a distinguishing characteristic.

*D. Liver Sausage.*—This sausage is distinctive in flavor and appearance by contrast with other classes of sausage due to the color and texture imparted to it by its liver content. A mixture of liver and pork, or liver, pork, and veal is popular for this class of sausage. In any case, liver constitutes at least 30 per cent of the total ingredients. Although liver sausage is usually smoked prior to cooking, some packers make an unsmoked variety. A good grade of smoked liver sausage is sometimes called braunschweiger.

There are many ingredient combinations used in the preparation of liver sausage. However, pork liver usually makes up the liver content which, as stated above, is used in an amount equal to not less than 30 per cent of the total ingredients. Sometimes nitrite or nitrate and nitrite are added to the ingredients. The blending and chopping of the ingredients result in a smooth homogenous mass which is stuffed directly into the casing. The stuffed product is then cooked or smoked and cooked depending on the local practice. The cooking is usually quite thorough with an internal temperature of approximately 165°F. reached throughout the article.

*Coarse-cut.*—*A. Polish.*—The beef ingredient is chopped through a $\frac{3}{8}$ inch plate and the pork ingredient is chopped through a $\frac{1}{2}$ inch plate. The meat is then mixed thoroughly with the flavoring materials, and nitrite or nitrate and nitrite, and the water. The mixture is stuffed in medium or wide hog rounds and tied off in links at least 6 inches long.

Since the mixture consists of coarsely chopped meat, the stuffed product is held from twelve to twenty-four hours to permit the nitrite to penetrate

into the meat particles and act on the meat pigment before the sausage is placed in the smokehouse. During the smoking the temperature of the smokehouse is raised to over 160°F. which thoroughly heats the product, raising its temperature to the point where it is safe to eat without further cooking. The sausage receives no additional cooking to the heating it receives in the smokehouse. It is showered with cold water as it is removed from the smokehouse.

*B. Smoked Pork Sausage (Country Style).*—As the name implies, this sausage is made entirely of pork with no added ingredients except the flavorings, and nitrite or nitrate and nitrite, and water. In the southern States, the smoked pork sausage is sometimes made without nitrate or nitrite. The pork is ground through a $\frac{1}{4}$ inch plate and then mixed with the other ingredients. The mixture is stuffed in a medium hog round and held for twelve hours to permit the nitrite to act on the meat before it is placed in the smokehouse. Since this sausage is classed as one that is customarily eaten without cooking, it is required to reach an internal temperature of at least 137°F. Usually this temperature is attained during the smoking operation.

*C. Berliner or New England.*—This is a characteristic, coarse-cut sausage stuffed in large casings. It is made predominantly of pork with a small percentage of beef. The meat is ground through a $\frac{3}{4}$ inch plate after which it is mixed with salt, sugar, and nitrite or nitrate and nitrite, and water. Because of the large pieces of meat, the mixture is held at a temperature of 38°F. for three or four days to permit the nitrite to penetrate the pieces of meat and act on its pigment. After this curing period, the mixture is stuffed in large artificial casings or in beef bungs or beef bladders. The product is then smoked at a temperature ranging from 120° to 145°F. after which it is cooked for four to six hours in water at a temperature of 160°F. A temperature of around 148°F. is attained throughout the product.

*D. Minced Bologna.*—This a coarsely chopped bologna stuffed in beef bungs or artificial casings of similar size. Usually pork predominates and the flavoring materials are similar to those used in the preparation of the finely cut varieties of bologna. The ingredients are mixed and the mixture is held for three to four days to permit the nitrite to penetrate the coarsely cut particles of meat before the mixture is stuffed in the casing and placed in the smokehouse. After being smoked for several hours at temperatures ranging from 120° to 145°F. the sausage is removed from the smokehouse and cooked in water from four to six hours at a temperaturue of 160°F. A temperature close to 150°F. is attained throughout the product during the cooking operation.

*E. Salami Cotto (Cooked Salami).*—By contrast with most salami this is subjected to relatively high temperatures in the smokehouse, which produces a cooked product. It is prepared predominantly of pork with beef added. The pork is ground through a $\frac{1}{4}$ inch plate and the beef through a $\frac{1}{4}$ inch plate. The ground meat is mixed with salt, sugar, black pepper and nitrite or nitrate and nitrite. The mixture is held at 38°F. for at least forty-eight hours to permit the nitrite to act on the meat pigment before the mixture is stuffed in the casing. After stuffing, the product is usually held for another twenty-four hours at 38°F. and then it is placed in the

smokehouse. The heating of the salami in the smokehouse is conducted without smoke. The temperature of the salami is raised above 137°F. to make it safe for eating without further cooking.

*F. Thuringer.*—This is a cooked, smoked, coarsely chopped sausage prepared predominantly of beef to which pork is added. It is stuffed in a wide hog round. To the coarsely ground meat are added sugar, ground white pepper, whole white pepper, mustard, salt, and nitrite or nitrate and nitrite. The chopped mixture is held at 38°F. for forth-eight hours to permit the nitrite to act on the meat pigment. It is then stuffed into the wide hog round and placed in the smokehouse where it is subjected to smoke at relatively low temperatures and finished witb a hot smoke during which the internal temperature of the sausage is raised above 137°F.

METTWURST.—This sausage is sometimes called "smearwurst" and is characterized by its soft spreading consistency. In this respect it differs from all otber classes of sausage. It is made predominantly of pork wbich is chopped fine with the salt, flavoring materials, and nitrite or nitrate and nitrite. The ingredients are stuffed into a wide hog round or beef round and tied off in links 2 to 3 inches long. It is smoked at comparatively low temperatures. Since this class of sausage is customarily eaten by spreading it on bread by the consumer without any further preparation, it is necessary that the pork ingredient be treated by one of the methods to destroy possible live trichinæ. The processing of the sausage does not usually accomplish this because the smokehouse temperature is not high enough to raise the temperature of the sausage over 137°F. So-called certified pork is therefore used as an ingredient. Suck pork is identified as having been treated to destroy possible live tricbinæ and this is usually done by freezing. Viable trichinæ are destroyed in pork that is frozen for twenty days at 5°F., ten days at −10°F., or six days at −20°F.

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*Cervelats. Farmer and Holsteiner.*—A combination of beef and pork is used in preparing these sausages, with beef predominating. The beef is chopped separately to a medium fine texture while the pork is cut into pieces about ½ inch in thickness. The meat is then mixed thoroughly with salt, spices, and nitrite or nitrate and nitrite. This mixture is stuffed in beef middles of a medium width for the manufacture of the farmer variety while for the holsteiner variety it is stuffed in wide beef rounds. Before being stuffed in the casings, the mixture is held for from two to three days to permit the nitrite to act on the meat. After stuffing, the sausage is allowed to hang for about twelve hours before smoking. It is given a heavy

smoke. The temperature is raised in the smokehouse toward the end of the smoking period to attain an internal temperature of at least 137°F. throughout the product. After smoking, the sausage is allowed to hang in a dry room until the desired consistency is attained.

*Thuringer.*—Beef also predominates in the beef and pork mixture and this mixture is chopped to a moderate degree of fineness through a $\frac{1}{8}$ inch plate. It is mixed with salt, spices, and nitrite or nitrate and nitrite after which it is held at 38°F. to permit the nitrite to act on the meat. The mixture is then stuffed in hog bungs or sewed hog bungs. It is left to hang in a drying room for from one to two days at a temperature of 55°F. after which it is given a two-day smoke at relatively low temperatures, the temperature gradually rising to 110°F. This treatment produces a tangy flavor in the thuringer and to facilitate this a harmless bacterial starter of the acidophilus type is sometimes added to the ingredients. Since the processing of this sausage would not destroy possible live trichinæ, the pork ingredient is certified to its having been previously treated to make it safe against trichinæ.

*Mortadella.*—Pork predominates as an ingredient in this class of sausage and it is mixed with beef and, sometimes, veal. A distinguishing characteristic is the presence of cubed pork fat distributed throughout the meat mixture. The pork and beef are ground to a medium degree of fineness and this is mixed with salt, spices, and nitrite or nitrate and nitrite. This mixture is held at 38°F. for one or two days to permit the nitrite to act on the meat after which it is mixed with the cubed pork fat and stuffed into small or medium-size beef bladders. The product is then usually held in a cooler for twenty-four hours after which it is transferred to a smokehouse that is equipped for heating to approximately 160°F. Mortadella is held at relatively low temperatures in the smokehouse for the first four hours and then the temperature is raised gradually to about 120°F. at the end of the first twelve hours. During the next twelve to eighteen hours the temperature in the smokehouse is raised to approximately 160°F. and held until an internal temperature of 140°F. is attained throughout the product.

*Lebanon.*—This is an all-beef sausage. The beef is ground to a medium degree of fineness and mixed with salt, sugar, spices, and nitrite or nitrate and nitrite. Sometimes the beef is thoroughly cured before it is chopped and mixed with the other ingredients. The mixture is stuffed in a beef bung and smoked in a well-ventilated smokehouse for from five days to two weeks in a wet, cold smoke. Weather conditions vary the smoking time. A harmless bacterial starter of the acidophilus type may be included in the ingredients for the purpose of controlled flavor development. The finished product is characterized by a tangy flavor traceable to the growth of this type of organism during the processing of the product.

DRY (HARD DRY).—This class of sausage is hung to dry for periods ranging from one month to six months. Mechanically controlled drying rooms are provided so that the conditions surrounding the product while it is hanging in the drying room will not be affected by outside weather conditions. The effectiveness of this control is related directly to the success of the drying process and if properly performed will hold to a minimum the formation of mold on the outside of the sausage. One objective is to so maintain the

surface of the casing that moisture from the interior of the sausage will be extracted gradually and constantly. If this drying out process progresses properly, no hollow spots will develop in the product and it will set up as a firm, compact mass. This is significant, particularly in that if spaces develop inside the product interior mold may form and ruin the product. The confining of moisture within the product not only favors the development of interior mold but also produces souring and spoilage. Temperatures maintained in sausage drying rooms range from 52° to 56°F. and the relative humidity from 65 to 80 per cent depending on the character of the product. The system is designed so that the conditioned air is distributed uniformly throughout the drying room. Different grades of sausage require different rates of air circulation. For example, sausages in beef bungs need more draft for drying than sausages in beef rounds.

Most dry sausage contains pork as an ingredient, and it must therefore be treated by a method that will destroy possible live trichinæ. Since frozen pork is not considered desirable for the preparation of dry sausage and heating is not employed in the process, dry sausage is processed by a combination of curing and drying that will assure its safety for eating by the consumer without any further processing.

One of five methods is used. These methods are recognized as adequate for the destruction of possible live trichinæ by the meat inspection service of the United States Department of Agriculture (page 532 of the Appendix).

*Salamis.—Milano.*—A mixture of pork and beef with pork predominating is used in preparing this class of dry sausage. The beef is ground to a fairly fine consistency while the pork is given a coarser grind. The pork and beef are then mixed along with salt, sugar, spices, and nitrite or nitrate and nitrite. The mixture is held at 38°F. for a day or two to give the nitrite an opportunity to act on the meat. The mixture is then stuffed in hog bungs. The stuffed product is hung in what is called the green room to permit the excess moisture to drip from the casing and evaporate from its surface. After this preliminary drying the salami is closely bound with Italian hemp. It is then hung in the drying room and not smoked.

*Genoa.*—This class of salami is quite similar to the milano type except that it is usually stuffed in sewed hog bungs and the piece is generally shorter than the milano type, being from 16 to 20 inches long while the milano may run from 18 to 30 inches in length.

*B. C. Salami.*—This salami is sometimes referred to as the German type and differs from the milano and genoa or Italian types in that the ingredients are stuffed in a beef middle and it is smoked before being placed in the drying room. Another distinguishing feature is that the loops of twine surrounding the sausage are spaced considerably wider than is the case with the Italian types. Also, it is generally shorter, ranging from 11 to 15 inches in length.

*Pepperoni.*—The pepper content of its spicing characterizes this sausage. The pork and beef ingredients are coarsely chopped and mixed with salt, sugar, spices, and the nitrite or nitrate and nitrite. The mixture is held for forty-eight hours at a temperature of 38°F. to permit the nitrite to act on the meat and then it is stuffed in hog rounds and twin-tied in pieces 10 to 12 inches long. It is then hung in the drying room for the period of

time necessary to meet the requirements for the destruction of possible live trichinæ. This product is not smoked.

*Frizzie.*—It derives its name from the crinkled or irregular shape imparted to it by the hog middle in which it is stuffed. The finished article is from 10 to 12 inches long and approximately 3 inches in diameter, being wrapped closely with No. 9 Italian hemp. The pork and beef ingredients are chopped medium fine and mixed with the seasoning and nitrite or nitrate and nitrite after which it is held for one or two days at 38°F. to give the curing materials an opportunity to act on the meat ingredient. The stuffed product is placed in a drying room without smoking and is dried thoroughly for from sixty to ninety days or at least sufficiently to meet the requirement for the destruction of possible live trichinæ. Frizzies are also known as soppresata.

*Chorizos.*—This is a highly spiced Spanish type dry sausage generally made entirely of pork but sometimes containing a small percentage of beef. The meat is ground medium fine and mixed with salt, seasoning, and nitrite or nitrate and nitrite. The seasoning includes garlic, sweet red pepper, hot red pepper, chili powder, and, sometimes, white wine vinegar. The ingredients are stuffed into narrow or medium-wide hog rounds or wide sheep casings and linked in 3 or 4 inch lengths. It is then dried and lightly smoked after which it is dried again. The curing and drying process meets the requirement for the destruction of possible live trichinæ.

*Goteborg.*—(*Sometimes referred to as Swedish sausage*).—This class of dry sausage is characterized by its sweet flavor derived from its principal spice, cardamon. It is made from a mixture of pork and beef combined with salt, seasoning, sugar, and nitrite or nitrate and nitrite. The meat is rather coarsely chopped and the ingredients are stuffed in a wide beef middle cut approximately 18 inches long. It is given a heavy smoke and then dried for at least that length of time necessary to meet the requirements for the destruction of possible live trichinæ.

**2. Products Other Than Sausage That are Prepared in Casings.**—Sausage is the kind of food that lends itself easily to adulteration or imitation. It consists of a chopped up blend of ingredients in which an adulterant can easily be disguised. There is a constant temptation therefore to place on the market a product in a casing which resembles sausage but which in fact is not sausage because there is used in its preparation excessive amounts of substances, such as water, cereal, dried skim milk, soya flour, or ingredients that are foreign to sausage products, such as gelatin, tragacanth, or meats other than those derived from the carcasses of cattle, sheep, swine, or goats.

Products, such as bockwurst, liver pudding, pinkelwurst, kiska, headcheese, souse, lachschinken, and capocollo, are prepared in casings and do not meet the requirements for sausage but neither do they resemble sausage. On the other hand, products which resemble sausage and are prepared in casings are identified as imitation sausage.

*Imitation Sausage.*—The products that come in this class are usually made in imitation of frankfurters or bolognas. They bear a very close resemblance to sausage in appearance and taste but are usually prepared with amounts of water and cereal, dried skim milk, and soya flour con-

siderably in excess of the limitations placed on the use of these ingredients in sausage.

*Bockwurst.*—The ingredients used in the preparation of this product are finely chopped and stuffed in wide sheep rounds. The links are about the same length as frankfurters. The meat ingredients usually consist of veal and pork, aud in addition to spices, a common ingredient is milk which is used in suhstantial proportions. Finely chopped green onions aud parsley are also usual ingredients. Bockwurst is distrihuted to the trade in a fresh condition without receiving any cooking or other processing in the packing plant.

*Liver Pudding.*—A mixture of pork liver and meat hy-products to which is sometimes added soya flour. This mixture is chopped fine aud stuffed in a beef round. The stuffed article is usually tied off iu rings after which it is placed in a vat of hot water and thoroughly cooked. The consistency of the finished article is that of a pudding from which the article gets its name. Like other liver products the pork liver constitutes at least 30 per eent of the total of the ingredients used.

*Pinkelwurst.*—A mixture of beef fat, oat groats, water, onions, and spices is stuffed in a wide hog round. The finished product has the consistency of a dry pudding with the oat groats giving it a coarse texture. Its color is white with a tinge of straw color. The stuffed article is thoroughly cooked before heing shipped to the trade.

*Kiska.*—This article has the consistency of a heavy blood pudding and is made from pork, water, oat groats, pork liver, pork spleen, salt, beef hlood, and spices, and stuffed in a heef round. It is thoroughly cooked hefore it is shipped from the meat packing plant. Sections of the oat groats are quite apparent on the cut surface of the product.

*Headcheese.*—This is a jellied product consisting predominantly of pork by-products, such as snouts, pork cheeks, and pork skins. It is seasoned with onions and a combination of spices usually consisting of thyme, ground cloves, ground celery seed, nutmeg and white pepper. The pork by-products are coarsely chopped, mixed with the other ingredients, and stuffed in hog bungs, hog stomachs, or artificial casings. It is cooked thoroughly at temperatures ranging from 170° to 175°F.

*Souse.*—(*Sulze*).—This product is prepared in the same manner as headcheese except that vinegar is an ingredient and imparts to it a characteristic mildly sour taste. Since the vinegar tends to hydrolize the gelatin in the product, the gelatin content of souse is fortified by the addition of commercial gelatin.

*Lachschinken.*—Two boneless cured pork loins are stuffed side by side in a medium beef middle and heated in the smokehouse in an atmosphere of smoke until a minimum temperature of 137°F. is attained throughout the pork muscle tissue. The pork loins are sometimes sprinkled with pepper and paprika before they are placed in the casing. In some cases the product is given a so-called cold smoke. When this method is used the pork loins have been certified to their having been treated by a process of freezing or curing that is recognized as being adequate for the destruction of possible live trichinæ.

*Capocollo.*—A cured pork butt is rubbed with a mixture of paprika and

ground red pepper pods and stuffed into a beef bung. It is then smoked and air dried. Since capocollo is classed as a pork product customarily eaten without cooking the article is either heated in the smokehouse to a minimum temperature of 137°F. or the pork butts are certified to their having been treated either by freezing or curing with an approved method to destroy possible live trichinæ.

*Jellied Tongue.*—Cured, skinned pork, lamb, or sheep tongues are thoroughly cooked after which they are trimmed and rinsed thoroughly. They are then placed in a beef middle or artificial casing of comparable size and covered with a solution of 1 pound of gelatin in 5 to 7 pounds of warm water. The casing is stretched tightly over the tongues and tied off after which the product is cooled thoroughly and is then ready for the trade.

3. Other Products.—*Loaves.*—The most popular are those loaves made in oblong shape that make rectangular cross-section slices. A great many ingredient combinations are used and loaves fall roughly into two categories. Those identified as meat loaves make up one class and are subject to certain limitations concerning the ingredients used. The other class bears designations such as macaroni and cheese loaf, imitation chicken loaf, pimiento, pickle and cheese loaf, etc., in which a wide range of ingredients are used.

Loaves are frequently packaged in transparent hydrocellulose coverings or cellophane wrappers which are printed with the name of the product and the ingredient statement.

*Meat Loaves.*—These are prepared with various meat combinations along with cereal or dried skim milk added as a binder. A great variety of seasoning combinations are used; however, onions, pepper, and sage predominate. To facilitate chopping the meat and the blending of the ingredients a small amount of water is added which does not exceed 3 per cent of the total of the ingredients used.

A combination of pork and beef in the proportion of two to three parts of pork to one of beef is a popular meat formulation, as is a combination of veal and pork in approximately equal portions. A meat loaf consisting of pork and beef with cubes of American cheese distributed throughout is also a popular loaf and is given the designation "Meat and Cheese Loaf." Chopped corned beef is also processed in the form of a loaf.

*Other Loaves.*—Many kinds of vegetables, macaroni and cheese, pimiento and pickles, and a variety of meat by-products are blended with meat ingredients along with seasoning, binders such as cereal, dried skim milk and soya flour, and varying amounts of moisture to make a great variety of loaves. For example, a combination of beef, pork, macaroni, cheese, and cracker meal is prepared under the designation "Macaroni and Cheese Loaf." An article identified as "Imitation Chicken Loaf" is prepared from pork stomachs, beef tripe, veal, pork trimmings, flour, and pork stock. Another combination consisting of pimientos, pickles, cheese and pork is prepared under the designation "Pimiento, Pickle, and Cheese Loaf." Because these loaves are not represented as being meat loaves and are made of a great variety of ingredients, they are not held to the same requirements as to moisture and filler content as are meat loaves.

*Hamburger.* This very popular meat product is prepared by chopping

beef with or without the addition of beef fat to a medium coarse consistency. No moisture, seasoning, or flour of any kind is used. The amount of beef fat in the hamburger determines its quality but in no case does the fat, whether it is normal to the meat ingredient or added as such, exceed 30 per cent of the product.

*Pork Roll.*—Chopped pork is mixed with salt, nitrite or nitrate and nitrite, and flavoring usually consisting of pepper, and stuffed in a muslin container approximately 3 inches in diameter and from 18 to 24 inches in length. The stuffed article is then held for varying periods of time at temperatures which permit a tangy flavor to develop. Harmless bacterial starters of the acidophilus type are sometimes used as ingredients for the purpose of facilitating the development of the desired tangy flavor. The consistency and appearance of the pork roll on cross-section are such as to place it within the category of pork products customarily eaten without cooking and it is usually heated in the smokehouse to at least 137°F. throughout to destroy possible live trichinæ. Pork roll is not usually smoked. To facilitate blending of the ingredients water is sometimes added but in an amount not to exceed 3 per cent of the total of the ingredients used.

*Cooked Pork Cuts.*—Cooked ham, or as it is sometimes called, "boiled ham" is the best known product in this category. Cured hams are boned and trimmed of their excess fat. The boned and fatted ham is pressed into a metal form and held in the form under pressure by a cover which is clamped to the form and pressed against the ham by the pressure of strong steel springs. The hams are then placed in large vats of water ranging in temperature from 165° to 185°F. They are cooked until they reach a minimum internal temperature ranging from 142° to 150°F. When the hams are removed from the cooking vat the tension of the lid is adjusted and the ham is allowed to cool before removing it from the mold. When the chilled ham is taken from the mold, it is washed in clear water to remove accumulations of gelatinous material and rendered fat left adhering to its surface, and it is then placed on racks in coolers exposed to a temperature of approximately 36°F. Uncured hams, cured pork shoulder picnics, pork loins, and pork shoulder butts are also sometimes cooked and they are handled very much the same in their preparation as are cooked hams.

*Scrapple.*—Pork and pork by-products usually make up the meat and meat by-product content of scrapple and total not less than 40 per cent of the ingredients used. The pork and pork by-products are cooked thoroughly and ground to a medium degree of fineness before being mixed with the other ingredients which usually consist of a mixture of cornmeal and corn flour, with pepper, sage, mace, nutmeg, and salt for seasoning. Sufficient water is added to bring the mixture to the desired consistency for further cooking. However, its amount is limited to that which will maintain the meat and meat by-product content at 40 per cent or higher. Sometimes rye flour or soya flour is used in addition to the cornmeal and corn flour.

*Chili Con Carne.*—This is usually distributed in 1-pound units as so-called bricks of chili con carne or in an artificial casing. The batch of ingredients which is thoroughly cooked contains at least 40 per cent meat and not more than 8 per cent individually or collectively of cereal or soya flour. There

is no limit to the fat content which usually consists of beef fat and is present in substantial proportions to facilitate firming up of the finished product to a solid consistency. Chili con carne is usually a highly flavored combination of coarsely chopped meat in a spiced fatty gravy. The flavorings usually consist of salt, paprika, chili pepper, onions, garlic, ground cumin, oregano, coriander, and nutmeg.

*Stews.*—Beef stew and lamb stew are the ones most commonly prepared and they have respectively a beef and lamb content of not less than 25 per cent computed on the weight of the fresh meat. The meat, vegetables, water, seasoning, and flour are cooked thoroughly. The only significant variation in stews as they are prepared by various meat packers is the consistency of the gravy content. In some cases the cooked meat and vegetables are contained in a thick gravy while in others a thin gravy is used.

**Canning.**—By contrast with food preservation by curing with salt and by smoking and drying which go back to antiquity, canning is a recent development. Furthermore, while the modern processes of curing and smoking are less concerned with preservation than with accomplishing a particular flavor in the meat, the process of canning is entirely one of preservation.

A Frenchman, Nicholas Appert, through work done by him between 1795 and 1810, is given credit for the method of preservation of food by the application of heat to food in a sealed container. During 1795 when France was at war with several hostile European nations and in the throes of a domestic revolution, its military forces and civilian population suffered from an acute food shortage. The French Government, realizing that one of the solutions to this problem would be a method of food preservation that would permit more flexibility in handling food supplies, offered a prize of 12,000 francs to any person how would develop a new, successful means for preserving foods. Appert was awarded the prize in 1809 and he published the first treatise on canning in 1810.

The causes of food spoilage were not known at the time of Appert's works and he had no technical training or experience. The explanation offered by Appert himself was that he observed how heat applied to food sealed in a container which was impervious to air had the peculiar quality of preventing the food from spoiling. Although he did not know the reason why, his many experiments led him to the conclusion that cleanliness and sanitation in the handling of the food and its perparation were necessary and that the sealing of the container must make it airtight.

It is believed that William Underwood, who came to America in 1817, started the first American canning operations in Boston in 1819 using Appert's procedure. In 1820, both Underwood in Boston and Thomas Kensett in New York were engaged in the commercial production of canned foods.

The name "tin can" is considered to be an abbreviation of the English term "tin cannister." Actually, it is somewhat of a misnomer, since it is in fact made from tin plate which is a mild steel plate bearing a thin coat of pure tin amounting to about 1.5 per cent of the tin plate. Tin plate, can enamels, and sealing compounds are the materials used in can manufacture.

The essential requirement of the tin plate is that it be corrosion resistant and strong enough to support and give rigidity to the particular class of container. The tin plate combines the corrosion resistant properties of tin and the physical strength of steel. The container must be strong enough to carry the product from the canner to the ultimate consumer and have the ability to withstand reasonable handling and shipping strains. All processed foods react on the inside of the container to some extent, however, in practice, this corrosion problem has usually been critical only for canned fruits. The successful use of tin plate in the food industry depends

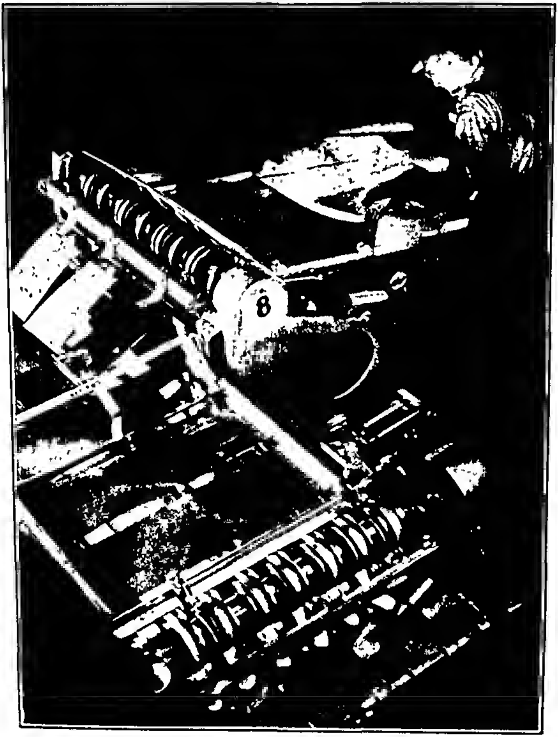


FIG. 108.—Slitter. (Furnished by American Can Co.)

in part on such factors as the amount of tin coating the plate and its continuity, but to a greater degree on the efficiency with which the small, ever-present areas of exposed steel are protected. This is never fully effective and may vary from near protection to very little. For this reason, interest in tin plate from the corrosion viewpoint has also been centered on the steel and because of success here, commercial control of corrosion has been achieved.

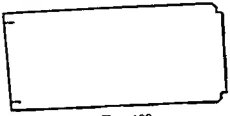

Fig. 109

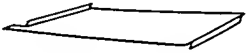

Fig. 110

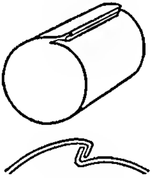

Fig 111

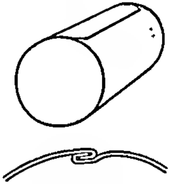

Fig. 112

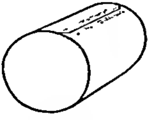

Fig 113

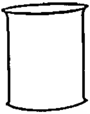

Fig. 114

Figs. 109–114.—Fabrication of the sanitary can. (Furnished by American Can Co.)

Cans for processed foods are subjected to conditions of temperature and pressure that vary according to the severity of the heat processing that is required for producing commercial sterility. Meats may require steam pressure processing of ten to two hundred minutes duration at temperatures of 235° to 260°F., depending on the consistency of the product in the can, the can size, and the pH of the product. During heating a differential pressure builds up within the can by comparison with the retort pressure as much as 20 pounds per square inch. The can ends must, therefore, resist permanent distortion at the countersink area as the retorts are opened

and the cans are chilled. Also, some canned products are closed under mechanical vacuum preparatory to their heat processing resulting in a negative pressure of 15 to 20 inches at the time of closure subjecting the can body to paneling or collapsing forces. The body of the can is designed to withstand these forces as well as subsequent strains during handling and shipping.

Before 1900, tin containers used commercially for foods were either of the now obsolete, hand-soldered, open top style, or of the more familiar "hole and cap style." In the center of the cap was a small hole or vent.

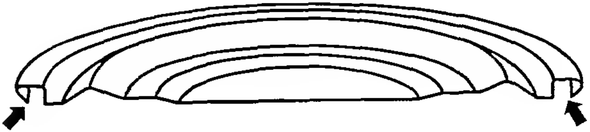

FIG. 115

FIG. 116

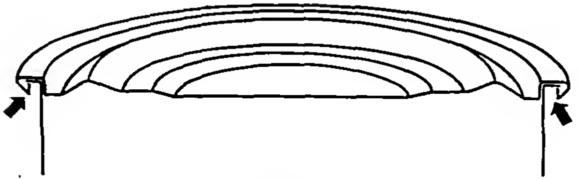

FIG. 117

FIGS. 115–117.—Fabrication of the can end. (Furnished by American Can Co.)

The food was placed in the can and the cap sealed on by a special soldering iron. The vent hole was then closed or tipped with solder and the canned product was ready for heat processing.

A new style of can was introduced about 1900 known as the "sanitary" style.

**The "Sanitary" Can.**—Cans are made on a series of machines collectively known as a "can line." Sheets of tin plate are first fed by hand into a slitter (Fig. 108) which cuts them into "body blanks" from which the body

is later formed. The body blanks are then fed into the bodymaker where a sequence of automatic operations is performed to complete the cylindrical body of the can.

The first station on the bodymaker notches the body blanks (Fig. 109). They are then hooked (Fig. 110) and the hooked blanks formed around the bodymaker (Fig. 111) and bumped to form the side seam of the can (Fig. 112).

The formed body then passes over fluxing wheels and then to the solder bath where revolving rolls apply solder to the outside of the side seam (Fig. 113). The soldered body next passes over a revolving solder wipe which removes excess solder from the outside of the can, after which it passes over a cooling section and is then led to the flanger, where the ends are curled outwardly by special pilots to form the so-called "flange" (Fig. 114).

At the same time that the can bodies are being fabricated, the ends are also being made by cutting the sheets of tin plate to the proper size with scroll shears and punching the ends out in a punch-press. The ends then pass through a machine which curls the edges inwardly (Fig. 115). Curled ends then go to the compound liner where a continuous ribbon of sealing "compound," a rubber gasket material, is extruded from a nozzle as a liquid and placed near the circumference within the curl (Fig. 116). Next a special machine dries the compound and the covers are complete. This compound serves as a sealing medium between metal curl of cover and metal flange of can body. Relationship of parts are shown in figure 117.

After the flanged bodies leave the flanger, they proceed to the double-seamer where one end is applied. This operation is essentially the same as that used in the canning factory for sealing on the top of the can. After one end is sealed on, the cans go to a testing machine which, by means of air pressure, tests them for leaks, and automatically discards any that are faulty. After testing, the cans are loaded into shipping cartons or directly into paper-lined box cars for shipment. The covers are packed separately in fiber tubes and shipped with the cans.

Enamel-lined cans are manufactured in the same manner as plain cans, except that the enamels are usually baked onto the sheets in gas-fired ovens before the bodies and ends are manufactured as described above.

*Sealing Compounds.*—An essential factor in the development of the open top "sanitary" can is the use of a suitable material for sealing the can end to the flanged body. The first sealing compound used was one consisting of a simple dispersion of rubber in benzol which, after being applied, was dusted with asbestos powder.

Synthetic rubber has been extensively substituted for natural rubber for some purposes, particularly where fat and oil solvent resistance is required. It is important that the sealing compound be resilient so that it will adjust itself to variations in seam tightness and fill, or crevices and irregularities of the double seam. This resilience must be retained over a temperature range from below room temperature to above 260°F.

The sealing compound must adhere to both tin plate and enameled tin plate, it must be impermeable to liquids and gases, it must not impart odor or taste to the product in the can, also it must not be affected by the product. All this is necessary if the compound is to possess vacuum holding

qualities and resist the heat processing so that the result is an adequately processed product in an airtight can.

*Solder.*—Until World War II solder composed of 30 per cent tin and 70 per cent lead was used. Occasionally the 40 per cent tin and 60 per cent lead solder or 60 per cent tin and 40 per cent lead solder was used. From then until about 1945, 80 per cent of all cans were made with a solder composed of 2 per cent tin and 98 per cent lead. About this time several instances of solder pellets in baby food occurred which aroused the Food and Drug Administration. For a short time, while a study was conducted to

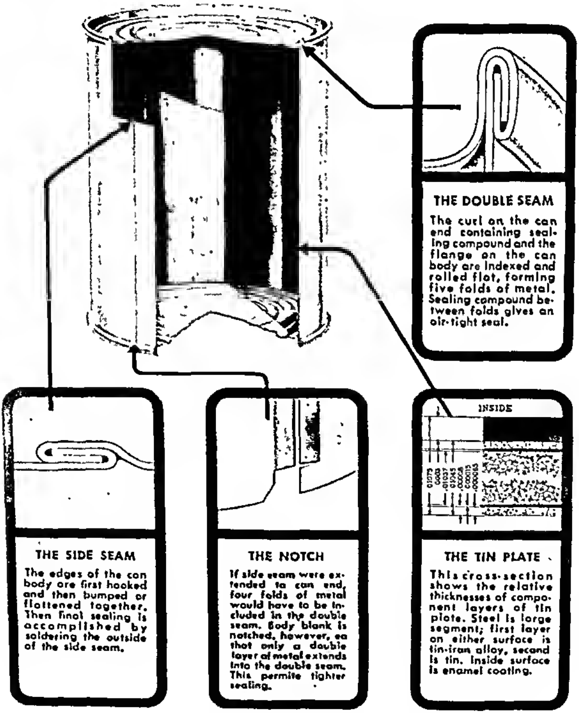


Fig. 118.—Architecture of the enameled sanitary tin can. (Furnished by American Can Co.)

determine the potential hazard of high lead solder, a solder of 95 per cent tin and 5 per cent lead was used on cans.

Studies were made in which extensive feeding tests were conducted on rats and dogs with solder pellets of high lead content as well as with foods which had been exposed to large areas of the solder while being processed. Also, chemical analyses were performed by the Food and Drug Administration on food items processed in cans made with high lead content solder. Conclusions were reached that no hazard results from the use of high lead content solder. Apparently a protective coating (perhaps the oxide) is formed on the surface of the pellet to prevent the metal from being dissolved. At the present time 80 per cent of all cans are made with a 2 per cent tin and 98 per cent lead solder. For hand-soldering and for evaporated milk cans, a 30 per cent tin and 70 per cent lead solder is used. The higher tin content solders are not acceptable to industry because of their high melting point.

*Inside Enamels.*—The use of inside enamels became quite extensive during World War II when electrolytic tin plate was substituted for hot dip tin plate as a tin conservation measure. Inside enamel is used primarily in cans for processing meats to eliminate sulphide discoloration on the inside of the container and the product. Also, enamel is used to reduce can corrosion for such products as chili con carne.

Many meat products contain ingredients which attack can enamels and this, therefore, requires careful selection of the enamel for a particular purpose. Ingredients such as spices, fats, oil, acid, and liver attack certain enamels. Highly spiced products exert a softening effect on enamel coatings. This applies particularly to those spices which have a high volatile oil content.

For the prevention of sulphide discoloration an enamel in which zinc oxide is incorporated has been found to be most effective. However, such a coating has very little resistance to acids. Therefore, its use is avoided for products containing vinegar or a large proportion of tomato products.

*Can Storage.*—The location of the area in which the empty cans are to be stored is as close to the canning lines as is possible and still maintain good storage conditions. Empty cans are damaged easily and therefore storage space of adequate size and convenient location is provided so that the handling of the empty cans will be reduced to a minimum. Also, the storage space is clean and dry so that the cans will remain free from rust and dirt. It is desirable to furnish some heating facilities in the storage area to prevent wide variations in temperature between the cans and the surrounding atmosphere to avoid condensation of moisture on the cans.

*Lithography.*—It is common practice for meat canners to have their labels lithographed directly on the tin container. Under adverse conditions the lithography may be partially obliterated either chemically or mechanically. Of the two, chemical obliteration is the one most commonly encountered. The chemical removal of lithography sometimes occurs in the retort during the heat processing and is caused by boiler compound. Under certain adverse conditions the surging of the boiler may expel some of the alkaline compound along with the steam which is carried into the retorts.

The chemical lifting of the lithography may also occur during the washing of the filled can after it leaves the retort. It is the common practice to wash the filled cans following the steam pressure cooking to thoroughly clean the surface of the can to enhance its display characteristics. A mild detergent such as trisodium phosphate is usually used for this purpose. This cleaning operation may attack the lithography when the concentration of the detergent in the washing solution is too great or when the time that the can is exposed to the detergent is unduly extended. Also, an inadequate rinsing following the washing operation may allow traces of the detergent to remain on the container. The other method of washing the canned product is to thoroughly clean it prior to placing it in the retort. This has the advantage of thoroughly cleaning the can before the heat processing cooks the soil onto the external surfaces of the container. The same safeguards are necessary here to avoid partial removal of the lithography by solutions of detergents that are too strong or by inadequate rinsing that permits a residue of the detergent to remain on the container.

*Vacuum.*—Air is present in most canned foods after the can is filled and before the top is sealed on the can. This air occurs in voids in the product, as occluded and dissolved air in the product, and in the head space above the product. The earliest method of removing air from canned foods was by heating the product in the can before closure. Later, the method of removing the air by vacuum was developed. Each method is still widely used depending somewhat upon the type of product, conditions of operation, and degree of vacuum that is desired in the closed container.

Various methods of pre-heating foods in the can prior to closure are used for obtaining vacuum in the closed can. The product may be heated prior to filling or after filling or it may be heated both before and after filling. The heat is used to expand the product, to expand and drive out the occluded and dissolved gases in the product and to rarefy the air in the head space before closure. The length of time that the heating is conducted and the final temperature attained before closure have direct relationship to the ultimate vacuum in the can.

At any given temperature variations in the amount of head space will also affect the final vacuum in the can. As the amount of head space decreases the vacuum increases quite rapidly.

The amount of air in the void spaces and that occluded and dissolved in the product is variable depending on the particular product and the method used in its mixing and filling. Many processors mix under vacuum the ingredients of a product prior to its being placed in the can. In any case, the amount of heating that is necessary to exhaust a particular product to the degree that it will give the desired vacuum in the closed can can only be determined by actual test. It has even been found that a short, high temperature heating will result in a lower vacuum than if a longer time at a more moderate temperature is used.

Under practical closing machine conditions it appears that the vapor pressure relationship for displacement of air in the head space does not play a significant role until temperatures of almost boiling are reached. This is probably due mainly to the disturbing currents of air around the closing machine. Consequently, until closing temperatures almost reach

the boiling point, the major factor in producing vacuums in cans having a head space is contraction of the product after cooling.

*Mechanical Vacuum.*—With this method the filled can while cold or at a rather low temperature enters the closing machine where the cover is loosely clinched on the can without forming an airtight seal. The can then passes into a vacuum chamber with which the closing machine is provided. The can is then subjected to a vacuum for an instant in the vacuum chamber and the can is sealed by clinching the cover tightly on it. The sealed can is then ejected from the vacuum chamber.

This method of exhausting air from canned foods subjects the contents of the can to a vacuum for a rather short period of time before closure. Therefore, the air is withdrawn mainly from the head space and only partially from the product itself. This method of exhausting air from the canned product is well adapted to solid products, such as hams and similar cuts of meat. When it is used for canning chopped products the ingredients of the chopped product are usually mixed under vacuum to eliminate the voids in the product and the occluded and dissolved air.

*Closure.*—The sealing of the cover on the can, or closing or double seaming as it is called in the industry, is one of the most important steps in the canning procedure. The sealing compound originally present on the cover supplies the material between the layers of metal necessary to insure a permanent, hermetical seal of the container.

Each can as it leaves the closing machine is examined to detect imperfect closure. This examination is necessary not only to pick out those cans which have not been closed properly so that their contents will not be contaminated during the heat processing that follows, but should a closing machine become out of adjustment a large number of defective cans will be produced before appropriate correction is made.

*Heat Processing.*—The objective of heat processing of canned foods is to heat the food in the can to that degree that will prevent enzymatic or microbiological activity in the food during ordinary conditions of storage. The adequacy of the heat processing is determined by the length of time that the food must be subjected to a given temperature in order to accomplish this objective. The destruction of the enzymes, molds, and yeasts presents little or no problem since these common causes of food spoilage are relatively easily inhibited or destroyed in heat processes as they are carried out commercially. The major problem in heat processing is the control of anaerobic bacteria which produce spores capable of growing without oxygen or in the presence of a limited amount of oxygen. It is the destruction of these spores which represent the most heat-resistant phase of the bacterial life cycle, that requires the most attention.

There is close synchronization of can filling lines and the heat processing of the filled can. The best practice is to heat process immediately after filling and closing the can. This applies equally to hot-packed and cold-packed product.

From the standpoint of heat processing requirements foods are classed in two types, the "acid" foods have a pH below 4.5 and the "low-acid" foods with a pH of 4.5 or above. Common examples of acid foods are

fruits, tomatoes, and sauerkraut. Among the low acid foods are included most vegetables, milk, fish, and meats and meat products.

Usually, the spores of food spoilage bacteria either will not germinate in the acid foods or are easily destroyed at the pH levels of such foods at relatively low temperatures. The same spores, however, if not destroyed will grow and flourish in the low acid foods.

It is possible to process canned acid foods at the temperature of boiling water or even lower depending on the nature of the product and the type of processing operation. The heat processing of canned low-acid foods requires higher temperatures to destroy the heat-resistant spores of food spoilage bacteria.

The heat processing requirements for canned foods are accurately determined since the majority of them are sensitive to heat and deteriorate in quality if cooking is too prolonged. In general, the shorter the process the better the quality of the food in the finished canned article.

The method usually used in the processing of canned products is the so-called batch method. Here, batches of canned product are processed under steam pressure in a sealed, steel tank called a retort. The cans are packed in metal baskets or similar device for handling volume of product conveniently in and out of the retort. The steam being exhausted from a retort when the cooking process is completed. The processed cans are removed from the retort and transported to tanks of cold water or areas where the product is chilled by spraying with cold water. The retort is again filled and sealed and the steam is injected into the retort until the desired temperature is again attained for the cooking process.

In some canning plants the batch method of processing canned product has been replaced by a continuous pressure cooker and cooler line. This has become a standard method for in-can processing for general application.

In the continuous pressure cooker and cooler lines, in-can sterilization is handled continuously and each can is handled independently and automatically at speeds up to 450 cans per minute. Processing temperature may be controlled as high as 270°F. These cookers and coolers have special features which make them capable of handling a wide variety of product.

*Aseptic Canning.*—This process embodies a combination of the principles of short high-temperature sterilization and aseptic canning methods. It differs from conventional canning methods in that the product is quickly sterilized and cooled before it is sealed in the can. This is accomplished by pumping the product successively through the heating, holding, and cooling sections of a closed heat-exchange system. The product thus sterilized and cooled under pressure flows continuously from the heat-exchange system to the aseptic canning machine in which it is filled and sealed in sterile containers without exposure to air or atmospheric contamination.

The canning procedure consists of four separate operations which are carried out simultaneously in a closed inter-connected system as a continuous process. The operations are: (1) sterilization of the product under pressure at a high temperature by quickly heating, holding, and cooling it in a continuous flow-type pressure cooker; (2) sterilization of the containers and covers with super-heated steam or other hot gas; (3) filling of the cold

sterile product into the sterile containers; and (4) aseptic sealing of the containers with sterile covers.

The various opertions are synchronized mechanically so that the raw product, containers, covers, and finished canned product move through the system without interruption. The product is maintained under pressure throughout the sterilization process and the filling and canning operations are carried out in an atmosphere of super-heated steam or other sterile inert gas. Contamination is thus effectively prevented.

**Canned Ham.**—Until 1930 with few exceptions American meat canners pre-cooked cured hams before canning. Canned hams imported from European countries prior to that time became very popular in the United States. The principal difference in the processing of the American canned ham and the European canned ham was that the Europeans did not pre-cook the ham before placing it in the can. The only cooking that the European canned ham received was that resulting from the heat processing of the ham sealed in the can. Since 1930 practically the entire volume of canned cooked hams prepared in the United States follows the European practice of placing an uncooked cured ham in the can and heat processing it after sealing it in the can.

Hams that are intended to be canned are cured by the sweet pickle method using the quick curing process in which the pickle is injected into the arterial system of the ham. The amount of pickle injected into the ham is limited to that which will hold the gain in weight of the ham during the curing process to not more than 8 per cent. The cured ham is sometimes given a very little smoke as part of its preparation for canning. In all cases it is boned. The ham is skinned with a small amount of skin sometimes being left attached to the ham at its shank end. The excess subcutaneous fat is also removed from the ham before it is placed in the can.

The canned hams are heat processed in hot water to reach a temperature throughout the canned article of not lower than 150°F. and usually not higher than 160°F. This degree of heat processing does not protect the canned ham against spoilage under all conditions of storage. Accordingly, it must be held under refrigeration and its label bears the warning "Perishable, Keep Under Refrigeration." Attempts have been made to subject canned cooked hams to a degree of heat processing adequate to protect them against spoilage under ordinary conditions of storage but they have proved to be unsatisfactory due to the fact that the high degree of heat and the length of time required for heat penetration produces a canned article that is not competitive with the one that is sold under the warning "Perishable" statement.

**Luncheon Meat.**—This popular canned product is for the most part prepared exclusively with chopped pork. Small amounts of chopped beef are sometimes mixed with the chopped pork, however, it is necessary that the article consist predominantly of pork to give it desirable qualities of juiciness and taste. The chopped meat is mixed with one of the curing mixtures consisting of salt, nitrate, nitrite, and sugar. Water not to exceed 3 per cent of the total ingredients is used to facilitate the mixing and distribution of the curing materials uniformly throughout the chopped product. Flavorings and spices are also added to the mixture.

The mixing of the chopped meat and the added ingredients is usually done under vacuum for the purpose of excluding any air that might otherwise be trapped in the product during its mixing. This properly prepares the mixture for canning since it is not pre-cooked prior to canning and the exhausting of the canned product prior to closure is performed in the vacuum chamber of the closing machine. The pull of the vacuum on the canned product is so transitory at this point that any air which might be trapped in the product would not be exhausted from it.

Luncheon meat is processed in a variety of container sizes. Those sizes that are displayed on shelves in the retail stores and exposed to room temperature are heat processed to a degree that accomplishes commercial sterility. These sizes range from the popular 12-ounce container to the 3-pound size. The larger sizes ranging from 3 to 6 pounds are not heat processed to a degree that would make them stable under ordinary atmospheric conditions. These sizes are labeled with the warning statement "Perishable, Keep Under Refrigeration," and are kept under refrigeration during their handling incident to retail distribution.

**Corned Beef Hash.**—This canned product consists of a mixture of diced potatoes, chopped corned beef, onions and flavoring materials such as spices and spice extractives. The chopped corned beef consists of at least 35 per cent of the total ingredients computed on the weight of the cooked and trimmed meat. The cooked meat represents 70 per cent by weight of the uncooked meat used.

Generally, the ingredients are mixed and heated thoroughly in a cooking kettle and the cans are filled with the hot mixture. Thermal exhaustion of the air in the product and the can usually precedes closure.

**Chili Con Carne and Chili Con Carne With Beans.**—Chili con carne consists of a mixture of chopped meat and a thick gravy highly seasoned with chili peppers. The meat consists of 40 per cent of the total ingredients computed on the weight of the fresh meat used. Chili con carne with beans is a mixture of beans, chopped meat and gravy, with the meat making up 25 per cent of the total ingredients also computed on the weight of the fresh meat. In both cases the mixture may contain up to 8 per cent individually or collectively of cereal or soya flour. These products are made by mixing the ingredients in a cooking kettle where they are heated thoroughly and the hot mixture is placed in the can. Thermal exhaustion is relied upon preparatory to closure.

**Stews.**—Beef stew and lamb stew are the stews usually canned by meat packers. They contain not less than 25 per cent of meat computed on the weight of the fresh meat and the other ingredients are those usual to stews such as a variety of vegetables and gravy. The mixture is heated thoroughly in a cooking kettle and it is filled hot into the can. Thermal exhaustion precedes closure.

**Deviled Ham.**—This is canned finely chopped ham that has spreading consistency. Cured hams are cooked and chopped and the finely chopped meat is mixed with spices. The hot mixture is filled in the can and thermal exhaustion is relied upon prior to closure. The canned product does not contain any more moisture than is normal to fresh ham and the fat content is limited to 35 per cent.

Tamales.—These are canned either in sauce or a slightly saline solution. The tamale is formed by enclosing a center of meat mixture with a covering of cornmeal mush. The tamale is then sometimes enclosed in a parchment wrapper or a clean cornhusk. The meat content of the canned tamales is not less than 20 per cent of the total content of the can. The tamales are packed upright in the can and the can is then filled either with the hot sauce or hot salt solution. Before closure the filled can usually passes through a heated chamber for the purpose of subjecting the can to thorough thermal exhaustion after which it passes through the closing machine.

Liver Products.—Liver spread is the one most commonly canned. This product contains at least 30 per cent liver mixed with a paste having a base of farinaceous materials or soya product. The mixture is prepared in a cooking kettle and filled hot into the can. Closure follows thermal exhaustion.

Spaghetti With Meat Balls and Sauce.—The cooked spaghetti, meat balls and sauce are filled separately into the can. The amount of meat used constitutes not less than 12 per cent of the total canned mixture and this is computed on the weight of the fresh meat. The meat balls are usually prepared with not more than 12 per cent singly or collectively of farinaceous material, soya flour and dried skim milk. The sauce is quite hot when it is added to the can covering the spaghetti and meat ball components. The filled can is then usually passed through a heated chamber where thermal exhaustion is completed before closure.

Sausage.—Viennas and frankfurters are the sausage products most commonly canned. The 4-ounce can of viennas is the most familiar product. Frankfurters are usually canned in the 12-ounce size. These sausage products are usually canned in a light brine which is not included in the statement of the quantity of contents on the label. When the viennas and frankfurters are prepared for canning the ingredients are usually mixed under a vacuum so that all voids are eliminated from the product. Usually the viennas are not linked but are cut in sections just large enough to fit the can. Each can is packed snugly with the particular sausage product and a hot light brine solution is poured in the can to fill up the spaces between the sausages and between the sausages and the container. The filled cans pass through a heated chamber to effect a thermal exhaust prior to closure.

The processing of canned viennas and canned frankfurters is done under careful controls since the sausage as it is removed from the container by the consumer must meet the moisture requirement for sausage which is permitted to be not more than 10 per cent of moisture in excess of that normal to the ingredients used in preparing the product. It is necessary, therefore, to strike a balance between the moisture content of the sausage as it is placed in the can and the moisture that the sausage will pick up from the packing fluid added to the sausage at the time of canning. This balance can be maintained within the limits for permitted moisture by canning a sausage of low moisture content and packing it snugly in the can so that the amount of packing fluid necessary to fill the empty spaces in the can will be reduced to a minimum.

Rendering.—Lard.—Pork fats used in the manufacture of lard come principally from the slaughtering department and from the department

where the chilled pork carcasses are cut up into their commercial parts. Fats from the slaughtering department are usually called killing fats or hot fats and those produced in the carcass cutting department are called cutting fats. The principal killing fats are leaf, ruffle, caul, ham facings, and head fat. The cutting fats are principally back fat, shoulder fat, belly trimmings, clear plates, and leaf lard scraps. The fats from different parts of the hog carcass have different degrees of hardness. The fats from the back and around the loin are relatively soft while those from the inside of the animal, such as the leaf, caul, and ruffle, are harder. For example, some of the cutting fats have a titer as low as 36°C. whereas the leaf fat may run as high as 41°C. Hardness of the fats also varies with the feed the animal had received. Fats from hogs fed on peanuts, soy beans, and garbage are much softer than fats from hogs fed on corn.

Cutting fats are sometimes stored for a short period of time in trucks under refrigeration between their removal from the carcass in the cutting department and the time they are placed in the rendering equipment. Killing fats on the other hand cannot be held safely for even a short period because they retain the body heat as they are accumulated in the slaughtering department. Their temperature is ideal for enzymatic action to progress in the cellular tissues of the fat as well as for bacterial growth, and unless they are promptly chilled or heated to temperatures beyond 160°F., decomposition will set in rapidly. Killing fats, therefore, are removed promptly from the slaughtering department to the rendering equipment where their temperature is quickly raised above the danger point.

*Refining.*—Some lard is refined by what is called the caustic method. The lard to be treated is heated to a temperature of 120°F. and sufficient caustic soda solution is added to neutralize completely the free fatty acid in the lard and in addition sufficient to equal .01 per cent of the weight of the lard to be refined. The lard and the caustic soda solution are thoroughly mixed and the temperature is raised slowly to around 145°F. The heating and agitation are stopped at this point and the lard is permitted to settle. After settling the clear supernatant lard is decanted off and filtered. The refined lard is not only lower in acidity but its smoke point is raised and it has a lighter color. Lard is also sometimes bleached as part of the refining process through the action of decolorizing agents such as diatomaceous earth and activated carbon. The lard to be bleached is heated to a temperature of 160° to 180°F. The decolorizing agents are then added and mixed thoroughly. However, they are not left in contact with the lard over fifteen minutes because they may impair the flavor of the lard if given a long exposure. The mixture is therefore pumped as quickly as possible through a filter press which removes the decolorizing agents. The lard is recirculated through the filter press until it becomes perfectly clear when it passes to a lard roll or some other type of equipment that will chill it rapidly.

Large quantities of lard must be stored from time to time and this is commonly done in tierces or in tanks. The storage tanks are sometimes equipped with refrigeration coils. When it is probable that the lard will be stored for a considerable period of time it is usually stored as the prime steam unrefined product. This class of lard has been found to possess the

best keeping qualities, and the storage in tierces which can usually be accomplished under some degree of refrigeration has proved to be the most satisfactory. The ideal temperature conditions for storing lard range from 50° to 60°F.

The most important point in connection with the storage of lard is that it must be free from moisture and impurities. The flavor and color of the lard should be of prime quality. The storage tanks or tierces must be clean. Another factor of importance is that the lard must be protected from contact with moisture while it is being stored. Its storage temperature should be as close to the 50° to 60°F. range as possible and the lard must not be reheated repeatedly. The storage tanks should be of convenient size and proper design and in a favorable location.

*Neutral Lard.*—The best quality of neutral lard is rendered from fresh leaf fat. Fresh back fat is also used in the rendering of neutral lard but its quality is sometimes identified as No. 2. As the leaf fat is taken from the carcass on the killing floor it is removed immediately to a cooler where it is spread out and chilled at freezer temperatures for approximately twenty-four hours. The chilled leaf fat is then run through a hasher and dropped into the water jacketed melting kettle. The kettle is provided with an agitator which not only tends to emulsify the hashed leaf fat but circulates it against the heated sides of the hot water jacket. The heating of the agitated material continues until the product in the kettle is raised to about 126°F. where it is held until there is a complete separation of the cellular fiber and the melted fat. This separation is aided by sprinkling very fine salt from time to time over the surface of the material. The agitator is stopped and raised completely out of the kettle as soon as the clear lard shows signs of separating from the tissue. The moisture and cellular tissue settle to the bottom of the tank and the clear lard is siphoned off. The clear neutral lard is filtered, allowed to cool to a temperature of about 118°F. and filled into barrels. The filled barrels are placed in a temperature of about 75°F. for twenty-four hours and then removed to a temperature of about 50°F. At this temperature the lard is allowed to grain for at least three days.

*Prime Steam Lard.*—The fats are rendered in closed tanks under pressure. Live steam at about 40 to 55 pounds pressure is turned into the tanks and the cooking is continued until the fat is completely separated from the cellular tissue.

The fats to be rendered are dumped into the tank until it is filled within 2 feet of the top. Sometimes this fat is parboiled before it is rendered. This is done in the tank by covering the fat with boiling water which is said to remove blood and other objectionable materials. The water used for parboiling is drawn off and sufficient water is again added to cover the fat. The tank is sealed and steam is injected directly into the contents of the tank until the desired steam pressure in the tank is attained. It is necessary to vent the air completely from the tank before sealing is completed so that the maximum rendering temperature will be reached. When rendering is completed the lard is drawn off from the rendering tank to a separating tank. In this tank any cooking water which may have remained in the lard is settled out. Every effort is made to remove every possible

bit of cooking water from the lard because it contains nitrogenous material that will readily decompose and sour the lard. After settling, the lard is pumped to the receiving tank where it is heated moderately to drive off any remaining moisture. After being thoroughly dried the prime steam lard is ready to be pumped to the refinery or for storage prior to refining.

*Dry Rendered Lard.*—The fats are rendered in a horizontal tank that is steam jacketed. The contents of the tank are agitated by arms or paddles rotating on a horizontal axis extending the length of the tank. The charging opening of the tank is equipped with a tight-fitting cover which in some cases is fitted with bolts that permit sealing the tank tightly to allow for building up considerable steam pressure inside the tank during the initial stages of the rendering process. This steam is produced from the moisture that is expelled from the fatty tissue during its rendering. Whether or not the tank is equipped for the generation of the steam pressure, the rendering is completed at atmospheric pressure or negative pressure depending on whether the tank is equipped with a condenser for the drawiug off of the vapors under vacuum. The separation of the fat from the cellular tissues is complete after the moisture has virtually been exhausted from the contents of the tank. In order that the color and quality of the rendered lard is not adversely affected by overprocessing, it is necessary to determine the end point of the cook very accurately. This is usually determined by the character of the tissue residue which when the rendering is completed has a sandy feel.

*Open Kettle Rendered Lard.*—Rendering of fats in a large open kettle over a fire was one of the earliest methods of commercial rendering and is employed by many farmers who render fats for their own use. The open kettle is still used commercially to a limited extent, however, the heat is applied to render the fat by a steam jacket surrounding the sides and bottom of the kettle. Usually the fat is hashed before it is placed in the kettle and usually the hashed fat is stirred mechanically so that the heat is distributed uniformly throughout it. As the rendering progresses, the moisture in the material is driven off in a cloud of steam. The rendering continues until all the moisture is driven off and the rendered fat has separated from the cellular tissues which take on the character of light brown, dry cracklings. At this point the lard is separated from the cracklings either by settling it in the rendering tank or by drawing the contents of the rendering tank off into a receiving tank. If the settling is done in the rendering tank, it is facilitated by sprinkling fine salt over the surface of the lard which hastens the precipitation of the cellular tissue. After this the lard is drawn off and filtered.

Where the contents of the rendering tank are drawn off to a receiving tank the lard passes through perforated strainers to strain out the cracklings and the lard is then filtered and runs into the storage tank. The residual rendered fat is removed from the cracklings by pressure.

*Lard Flakes.*—These are produced by hydrogenating lard using the same process as that employed for hardening vegetable oils. The lard is heated to a temperature well above 200°F. and the hydrogen gas is bubbled through it in the presence of a catalyst. The degree of hardness imparted to the lard can be controlled by limiting

the time that the lard is subjected to the process. The hydrogenation process in addition to hardening the lard adds stability to it, however, it does impart a characteristic undesirable odor which is removed by employing a deodorization process similar to that described on page 214. Lard flakes are prepared for the purpose of adding them to shortening or lard to raise the melting point of the mixture.

*Rearranged Lard.*—The molecular structure of lard has been regarded as not lending itself to the satisfactory incorporation and carrying of air through the baking process. A procedure that rearranges the physical structure of lard has been worked out that re-distributes the fatty acid radicals. This is done by heating the lard in the presence of an alkali metal alcoholate catalyst.

The preferred temperature for the reaction is around 155° F., although it can be carried out at a temperature just high enough to keep the lard liquid. However, the temperature range is critical to the process. The catalyst most generally used is sodium methoxide. About 0.5 per cent of the catalyst gives the best results and the molecular rearrangement is accomplished in about ten minutes. After the reaction is completed, the catalyst is completely removed and the lard is washed thoroughly with hot water. It is centrifuged to remove any remaining soaps and residual impurities, following which the lard is run through a vacuum dryer which removes the last traces of moisture. The resulting lard has a wide plastic range, none of the unsaturated fatty acids are affected by the process, and the nutritive values of the lard are retained.

*The Centrifuge Process.*—This system separates the rendered fat from the fatty tissue by a combination of grinding and centrifuging at comparatively moderate temperatures ranging from 160° to 180° F.

Rendering of fat under this system is started with the mechanical rupture of the fat tissue. The initial breakdown is done by an ordinary meat grinder with $\frac{3}{8}$ inch plate. The mass of ground, fatty tissue flows through a steam-jacketed pipe to a steam-jacketed kettle equipped with an agitator where the temperature of the ground product is raised to a temperature of 160° to 180° F. This gives the mass fluidity and prepares it for the centrifuge.

From the steam-jacketed kettles, the slurry is pumped to the first of two centrifuges which constitute the heart of the system. About 75 per cent of the non-fatty portion of the tissue is removed from the fat during this step. This tissue, which is made up of a combination of protein, water, and residual fat, is discharged from the centrifuge into a high-speed comminuter. Here, the material is chopped up into fine particles which are conveyed to a kettle. In the kettle this finely comminuted tissue is mixed with live steam which heats the product to approximately 200° F. This mixture goes through the second centrifuge which completes the removal of the protein and water from the fat.

Finally, the fat from both centrifuges is clarified, free of protein, and has a moisture content of less than 0.2 per cent. As a result of the relatively low rendering temperature and the rapid continuous process, the rendered fat is light in color, it has a low fatty acid content, the odor and taste are bland, and the stability is high.

*Blue Lard.*—Blue color is sometimes noted in steam rendered lard. It is

caused by a natural blue pigment in the fats and does not indicate any spoilage or deterioration which can be prevented. In fact, it may be regarded as an indication of careful rendering as it is seldom seen in an over-cooked lard and never seen in lard from old or poorly-handled fats.

Blue color can be eliminated only by bleaching with fuller's earth. It is removed readily by that process but is not affected by activated carbon bleaching. The amount of fuller's earth used should be small as blue coloring bleaches easily and any bleaching process tends to lower stability of the lard.

**Rendered Pork Fat.**—This category of rendered fat derived from fatty pork tissue was recognized in the 1930's by the U. S. Department of Agriculture. The Department examined into the practices of the American meat packing industry in its production of edible rendered fat from a great variety of edible fatty tissue derived from the pork carcass. It was recognized that all of the fatty tissue used in the process was edible in character, however, a question was raised as to whether it produced on rendering a fat that might properly be identified as lard. It was decided that there is sufficient difference between the fat rendered from uncured killing and cutting fats and that rendered from cured fats, organs, bones, detached skin, ears, tails, large blood vessels, skimmings, settlings, pressings and the like, to justify distinguishing between these two classes of rendered fat. It was decided that the term "lard" would be appropriate for the former and the term "rendered pork fat" appropriate for the latter. Except for the kind of fat used in the rendering process, the preparation of lard and rendered pork fat is quite similar. The processes usually employed are steam rendering and dry rendering.

**Edible Tallow.**—Killing and cutting fats derived from beef and lamb or mutton carcasses are the materials most commonly rendered in the production of edible tallow. In plants that produce oleo stock, the incompletely rendered residual fatty tissue from this operation is also used in the production of edible tallow. Steam rendering and dry rendering are the processes employed and the fat is separated from cellular tissues at a relatively high temperature. In the steam rendering process the rendering is done under 40 to 50 pounds of steam pressure and in the dry rendering process the temperature is well over 200°F. Edible tallow is a comparatively hard fat and is usually blended with vegetable oils in the manufacture of shortening.

**Shortening.—Shortening Composed of Vegetable and Animal Fats.**—Combinations of vegetable and animal fats have been popular as shortenings for many years. A standard formula consists of approximately 80 per cent of vegetable oil and 20 per cent of edible tallow or oleo stearine. Various combinations of fats are used. In recent years rendered pork fat has been used rather extensively in this class of shortening.

**Shortening Composed of Lard.**—With the popularizing of a hardened, stable, bland vegetable oil product of high shortening value, it became more and more difficult for the meat packing industry to move lard into consumption at volume and price levels consistent with production volume and cost. To meet this competition the meat packing industry developed a shortening made of lard that possesses physical characteristics comparable

the time that the lard is subjected to the process. The hydrogenation process in addition to hardening the lard adds stability to it, however, it does impart a characteristic undesirable odor which is removed by employing a deodorization process similar to that described on page 214. Lard flakes are prepared for the purpose of adding them to shortening or lard to raise the melting point of the mixture.

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to the popular vegetable oil shortenings. That is, the lard is bland, hardened, and of high shortening value. To permit it to be merchandized and handled at room temperature without refrigeration it is stabilized by the addition of an anti-oxidant. To assure that the resulting shortening will have the desired quality and stability, only lard of high quality is used in its manufacture.

**Puff Pastry Shortening.**—This shortening consists of a combination of vegetable and animal fats with 10 per cent added water and is prepared by the packing industry principally for distribution to bakers. The process of blending the ingredients is similar to that employed in the manufacture of oleomargarine.

**Oleo Stock.**—This is the rendered fat derived from the killing and cutting fats of beef and mutton or lamb carcasses rendered at a temperature not in excess of 170°F. The fats are first chilled thoroughly in a vat of cold water which also serves to dissolve out any residual blood that might be present in the blood vessels in the fatty tissue. The chilled fat is hashed directly into open kettles equipped with a hot water jacket around their sides and bottom. The hashed fat is agitated mechanically so that the heat will penetrate the mass uniformly and the heating and agitation are discontinued at that point when the liquid fat has separated from the cellular tissue. This usually occurs around 150°F. Finely ground salt is scattered over the surface of the rendered mass and as this settles it carries with it the moisture and cellular tissue, leaving the supernatant clear fat which is drawn off into trucks called "seeding" trucks in which the stock is separated into its oil and stearine content.

**Oleo Oil and Oleo Stearine.**—The seeding trucks containing the oleo stock are placed in a room where the temperature is maintained at 90°F. After about nine days the temperature throughout the contents of the truck drops to room temperature. At this temperature the oleo stearine is solid and has precipitated out having a white flaky consistency. The oleo oil is liquid at this temperature. The contents of the truck are then stirred vigorously to a granular consistency which prepares them for pressing. The oil is then separated from the stearine by filtering through heavy duck material called filter cloths. The oil is either used directly in oleomargarine manufacture or stored in tierces at 50°F. The stearine either goes directly into shortening manufacture or is placed in a bin from which it is packed in barrels for shipment.

**Oleomargarine.**—The greatest volume of oleomargarine is prepared with vegetable oils to the exclusion of animal fats. However, a substantial production consists of a combination of vegetable oils and animal fats along with the other ingredients normal to the product. Any edible rendered fat, oil or stearine derived from cattle, sheep, swine, or goats might be combined with the vegetable oils. In any case, the finished product contains at least 80 per cent of fat. To the fat is added cream, milk, skim milk, combinations of dried skim milk and water or a mixture of these. In making the combination of dry skim milk and water at least 10 per cent of dry skim milk is used. These milk products are pasteurized and are subjected to the action of harmless bacterial starters. The congealing of the fats with the milk products is usually accomplished by quickly

chilling the warm mixture of melted fat and milk. This is sometimes done by bringing the mixture into contact with cold water.

Other ingredients which may be used in the manufacture of oleomargarine but which if used do not result in lowering the fat content below 80 per cent, are artificial coloring, sodium benzoate, benzoic acid, vitamin A, vitamin D, artificial flavoring diacetyl, lecithin, mono-glycerides, diglycerides, sodium sulfo-acetate, butter, and salt. The sodium benzoate or benzoic acid does not exceed .01 per cent of the weight of the finished product. The vitamin A is added as fish liver oil or as a concentrate of vitamin A from fish liver oil (with any accompanying vitamin D or with or without added vitamin D concentrate) in such quantity that the finished oleomargarine contains not less than 9,000 U. S. P. units of vitamin A per pound. Lecithin, mono-glycerides, diglycerides, and sodium sulfoacetate are limited to not more than 0.05 per cent of the weight of the finished oleomargarine whether used individually or in combination.

# Chapter 11

# MEAT GRADING

**Purposes of a Grade Standardization and Its Application to Livestock and Meats.**—Class and grade standards for livestock and meats have for their primary purpose the establishment of a system of equitably dividing the normal quality range of a given kind of livestock or meat into smaller unit groups having similar specific uses as an aid to satisfactory sale and purchase. The success of any such standard for livestock and meats depends on its adoption and universal use by the industry. The guiding principle in drawing up grade specifications is that they are sound, practical, and factual. The purpose of specifications is not to emphasize or to stimulate a stricter requirement for the different grades, but to spell out, as by illustration and description, the requirements in terms of extrinsic and intrinsic characteristics that all may understand.

Efficient and intelligent production and marketing of livestock and merchandizing of meat are dependent on a knowledge of consumer preference for quality as identified by grades or some sort of system of segregation applied to the total range of quality. Hence, an understanding of consumer demand is necessary in order to provide producers with a guide to enable them to meet that demand.

Any system of grade standards implies some form of division of the range of quality and other essential characteristics based on factors common to all the units represented in the range. The groupings or grades are not made on a quantity distribution of the class but are based entirely on factors that determine the sum total of the characteristics that distinguish one group from another.

Grade designations then are terms that represent certain fixed degrees of excellence within the range for the purposes of economical and intelligent marketing. The number of grades in each class of meat or livestock is dependent upon the extremities in the quality range and on the number of distinct groups which can be accurately and readily identified by fixed and definite economic meaning and which covers or represents a minimum variation in the essential facts which distinguish one group from another. Grades, therefore, presuppose definite specifications which are thoroughly understood by buyer and seller and which are universally interpreted and applied in a consistent manner.

To be of any value from a practical standpoint any scheme of classifying and grading should fit the needs of the interest which it is designed to serve. It must strengthen the desirable features and unify the trade practices by eliminating differences between markets. This is most effectively accomplished through the adoption and use of grade terms with

definite meaning that is generally understood. Grade descriptions must be concise, specific, and easily understood. No grade standard will receive widespread use that fails to meet these requirements nor increase the efficiency of the distribution and marketing of any commodity.

Livestock and tbe meat obtained therefrom is a most complex commodity varying widely in quality, weight, and many other essential factors. Each specification presents a specific problem for the reason that the meat from different speeies is not wholly interchangeable as to consumer preferenee. Furthermore, farmers are not always able to produce the animals in the quantity and of the quality indieated by relative eonsumer demand for the different kinds and grades of meat.

While the consumer is considered an independent variable in establishing standards, it is apparent that the farmer is confronted witb problems involving produetion that are at times incompatible with consumer demands. The producer is adventurous, often exploring possible departures from the orthodox proeedures in production and marketing of bis animals. Consumers likewise often get reckless with their food dollar by purchases of new products of unestablished quality or brand. These practices tend to prevent a concentration around any establisbed grade segregation and the so-called liners between grades represent as large a proportion of the specific population as the typical examples of the grade.

The principle of the grading system lends encouragement to this situation when representatives of the grade having the minimum requirements will command as much or more consideration than those having the maximum qualifications of a grade. The continual efforts on the part of the consumer to select meat of a given grade with the greatest proportion of lean to bone and trimmable fat, together with a strong perference for smaller cuts, are having their effect on some ranchers as to the kind of cattle to breed and raise and upon the Corn Belt feeder as to the weight and degree of fatness that provides the popular beef.

**Historical.**—The course of events that led to the establishment of the Federal meat grading service parallels the development of the livestock and meat industry of this nation. No other country has anything that closely matches it, for the reason that meat produetion in this eountry has never been elosely geared to a meat export trade or to the preponderant produetion of any one partieular eommodity to the detriment of other kinds of meat. The ehief outlets for the meat production of the United States have been our own domestie markets. The partieular quality or brand of meat eonsumed has been markedly influenced by the general economie conditions of the eountry and by the changes in status and types of employment of the people. Of special signifieance is the faet that the changes ealled improvements are directly associated with and have been contributory to the eonstant improvement in the standard of living of the American people.

Back in the days when Mr. J. Ogden Armour and Mr. G. F. Swift, two New England Yankees, and others started in the meat business, slaughtering of cattle and the selling of the meat were almost entirely local enterprises. The so-called butcher bought his meat on the hoof, slaughtered it and retailed the meat. He was packer, distributor, transporter, and retailer

of all that which he slaughtered. The meat was passed over the block with no particular designation as to the quality. In those days beef was beef. Beef grading if conceived in those early days was restricted to those considerations that reflected differences in dressing percentage, commonly referred to in these times as yields.

There were two fundamental reasons why grading as it is practiced today was not actually important in earlier merchandizing practices:

1) The kinds of cattle in any particular area or locality were pretty much the same with respect to type. The degree of fatness varied with the season, the availability of feed, and price relationship between feed and cattle. So-called stall feeding was practiced sparingly, consequently the fatness of the cattle was determined very largely by the supply of grasses and other roughages.

2) Transportation was slow, precarious and restricted largely to local movements. Hence, the butcher depended upon local supplies of cattle for his beef. Consumers became thoroughly familiar with the quality of beef handled by their local butcher, which of necessity was pretty much the same, and changed only with the seasons and abundance of feed naturally provided.

The population multiplied and it spread from East to West. Likewise, the meat business expanded not altogether through the process of fission in which additional small butcher shops continued to be established but rather by consolidation and enlargement through development of slaughtering plants which relieved the retailer of the necessity of operating his own slaughtering plant. The slaughterers and the consumers tended to become more widely separated. The slaughtering of livestock moved toward the areas of production and the population tended to congregate around the areas of industrial development. Thus the focal points of meat supplies and consumption drifted wider and wider apart, the speed and distance being controlled by the development of transportation facilities and the development and expansion of livestock production.

The local butcher business was converted from a single independent business to one more complex in which he became dependent upon some central slaughtering plant for his meat supplies. Movement of meat is in refrigerated cars, consisting of large quantities, far in excess of the amount that could be handled immediately by the individual retailer. A middle man, the wholesaler, was created, one who took over the function of buying in large lots from the slaughterer or the packer and of selling in small lots to the individual retailers. Due to economic expediency wholesalers tended to situate themselves in the vicinity of the retailer areas.

Thus another complexity was introduced into the marketing processes which made it impractical for the wholesaler to personally examine and select the meat he purchased prior to the arrival at his place of business. Furthermore, the retailer found it increasingly burdensome on his time to personally examine and select his meat prior to purchase. The problem of purchasing uniform kinds and quality of meat was greatly accentuated by improvements in the breeding and management of livestock on the farm and ranches, which, for a time, had the effect of widening the range of quality. Hence the need for some practical means of describing quality

as a substitute for presale examination of the meat led to the use of numerous descriptive terms having some quality significance.

The first approach to the problem was the identification of beef with the geographical origin of the cattle. In some parts of the country this practice is followed even today. The Southeast continues to feature Western Beef and K. C. Beef. Such references as Range Cattle, Cornbelt Cattle, Native, and others are still used to signify or imply a particular quality of beef.

As production of livestock took on the role of high specialization in meat production and felt the influence of superior breeding and skilled management in the feedlots, such terms became practically meaningless. Other means of segregation became necessary in order to depict the narrower ranges of quality. To meet this demand such terms as Choice, Good, and Medium, and Western or Native came into common use by the trade. Just recently, a new term "genuine fed", inferring fattened on grain, has been proposed. Like many of the other designations intended to imply differences in characteristics of meat, "genuine fed" offers no tangible way of distinguishing the meat from grain fed animals as different from some similar in characteristics but not grain fed.

Cattle and sheep are so improved in accordance with the single objective of meat production that when fed in the Cornbelt for varying periods of time they lose much or all of the characteristics that identified them with the point of origin. Notwithstanding the marked development of the livestock industry toward a single standard, many of the original terms remain in usage even though they furnish no dependable reference to the quality of the meat.

As the meat industry expanded, the problems of identifying quality became more and more complicated since every handler was attempting to use a nomenclature of terms largely of his own choosing but which did not necessarily coincide with those of others engaged in similar business. Meanwhile the cattle producer and the sheep producer were forging ahead with an intensive program of improving their animals through the use of superior breeding stock and application of scientific methods in feeding and management only to run head-on with the confused and baffled consumer who was unable to recognize with confidence the improved and better meats from the other kinds due to the maze of terms employed by packers and wholesalers in identifying difference in quality of meat. Demand for uniform standards for meat grades rapidly developed throughout the livestock and meat industry as well as the consuming public. The demand was manifested through complaints from individuals and various organizations over a period of years. Consumers in all sections were continually being disappointed by their meat purchases and demanded some means by which they could determine high grade meat from the lower grades.

The lack of uniform standards had caused much misunderstanding, confusion, suspicion, and in some cases material losses, and every instance tended to pressure for the adoption of uniform national grade standards.

The first attempt to develop a uniform standard using grade terms nationally understood was undertaken in 1902 by the Agricultural Exper-

iment Station of the University of Illinois. The results of these studies provided the basis upon which the United States Department of Agriculture in 1916 set up tentative standards for the classes and grades of beef and for the preparation of Market Classes and Grades of Beef. These were published in 1924, as Department Bulletin 1246, the first of the grade standards issued by the United States Department of Agriculture. In these standards were embodied the fundamental principles of meat grading, first used in market news reporting work.

**Federal Meat Grading Service.**—The Federal grading of meat was first inaugurated by the United States Department of Agriculture in 1923 as a special service to the United States Shipping Board for the emergency fleet and other United States owned vessels to alleviate difficulties encountered in procurement of desired quality of beef. During the next two years the service was extended to other steamship companies, railroads, large hotels, followed by requests from Federal, State, and county hospitals and other governmental institutions and still later from wholesale meat dealers, chain stores and others.

After the grading service had functioned for about two years a series of meetings were held for the purpose of obtaining from the trade, criticisms, comments, and suggestions concerning the proposed standards. It was the general consensus that universal standards were highly advisable but considerable doubt was expressed by some as to the possibilities of uniform application of such standards. These meetings created widespread interest among the producers of livestock and the meat trade, especially those producers handling high grade cattle. Steps were taken forthwith by these producers to organize and support a general movement toward the adoption and extensive use of uniform official standards for both livestock and meat. The firm conviction of the leading cattle breeders and feeders in the principal cattle producing states led to the formation of an organization—The Better Beef Association—for the specific purpose of sponsoring the grading and grade stamping of beef.

The Secretary of Agriculture made a commitment to the Association to supervise the grading and grade stamping of beef for one year provided some satisfactory agreement could be reached between producers and packers.

At the end of the year a conference was called by the Secretary of the National Live Stock and Meat Board at which time definite plans were formulated for the development of the grading service and the date determined for inaugurating the service. Accordingly, the beef grading and stamping service was officially inaugurated on May 2, 1927, by the United States Department of Agriculture.

When the grading service was first installed it was agreed that only Prime and Choice beef would be grade stamped. Before the end of the first year the demand for graded meat had developed to the extent that the grade Good was added and within five years the grading program had to be further extended to identify steers, heifers, and cows with a complete schedule of grades.

The grading program made a very substantial growth during the first five years despite numerous handicaps. Much educational work was

performed by organizations favorable to the program to acquaint potential users of graded meat with the benefits to be derived from grading. This phase of the program was planned and directed by the Better Beef Association and the National Live Stock and Meat Board. The distribution of effective information by these two organizations created an enormous consumer demand for grade labeled, high quality beef, with the result that many opponents among the wholesale trade joined the supporters of the service in making graded beef available to the consumer, thus giving assurance that the grading program was fundamentally sound and practical. Its future success rests largely with two major accomplishments, neither of which has as yet been entirely mastered. This refers to the development of a grade standard in which the human element plays a minor role in determining the grade and, secondly, an objective measure of the factors that determine the grade in a manner intelligible to the retailer and consumer.

Three primary factors involving all the characteristics of the beef carcass are carefully considered in developing grade standards. They are conformation or shape, finish or degree of fatness, and quality.

The grades of meat are determined almost exclusively upon the exterior physical characteristics. While it may be true they are indicative of the relative acceptability of the meat, such limited considerations are not always dependable. The characteristics that are responsible for quality often are not discernible by the consumer. Many are aware of the importance of ageing in the development of flavor and tenderness but few can determine by examination whether or not the meat has been properly and adequately subjected to the process.

The extent to which marbling should be allowed to replace exterior fat as a consideration of finish in determining grade needs careful study. Incidentally marbling is a characteristic that can be quantitatively measured and charted, according to grade by weight and age. The matter of age in animals and its influence on grade has never been satisfactorily determined. The degree to which ripening of meat will compensate for age is another consideration that needs study.

The grading of all meat is performed in accordance with some standard, whether expressed in the form of written specifications or in accordance with points of view developed during the course of experience. Other characteristics inherent in meat or developed after processing may have a profound influence upon the nutritive qualities, as well as the edibility of the meat. None of these characteristics is considered in the determination of the grade of meat except insofar as they may be associated with certain of the physically apparent characteristics observed in formulating a decision as to the appropriate grade.

The actual performance of grading service is confronted with two principal problems; one, the establishment and maintaining of consistent interpretation and application of the grade standard by the individual grader, and two, getting all the graders to apply the standards uniformly.

The difficulties in the first case emanate in large measure from the individual grader in the application of his own system of grading. He, of necessity, must draw continually on his experience which in turn was

obtained under the direction of some private operator. Hence difficulties encountered in determining the grade according to the Federal Standard obviously tend to be solved in light of knowledge previously gained which, in many cases, is at variance with that employed by the Federal Meat Grading Service. Much time and training are often required to adjust the performance of a group of graders to a uniform method and procedure of grade analyses. But before such a task can be undertaken, it is necessary that all the teachers are in agreement and can demonstrate the interpretation and application of the standards uniformly so that every grader is being taught to apply the grade standards in a manner as nearly alike as is humanly possible to teach by demonstration.

**Organization of the Federal Meat Grading Service.**—Applicants for the grading service are grouped in small units called areas. An area may require the services of 6 to 20 graders. In each area is assigned a grader supervisor whose principal duty it is to work out grading schedules or itineraries for the graders and to maintain consistency and uniformity in the performance of the grading work. He spends almost his entire time with his graders reviewing their work and giving instructions as to the proper interpretation of the standards. He is also available to discuss standards with applicants and give grading demonstrations to interested groups.

It is not sufficient to have each area grade consistently, they must apply the standards uniformly with other areas. This is accomplished by grouping areas under the direction and supervision of a regional supervisor who has as his main duty the development and maintenance of a high correlation of consistency in the application of the standards between the areas assigned to him. There are seven of these regional supervisors and they constitute a committee frequently called into conference to discuss the technical and administrative phases of the grading service and particularly to participate in a correlation grading school of two days duration. Similar performances are conducted by regional supervisors in the areas of their respective regions.

Heading up the field organization is the National Supervisor and his supervisor assistants who travel the width and breadth of the country checking the grading in the different regions and seeing to it that the standards are being uniformly applied on a nation-wide scale. There are other men stationed at strategic points who spend their entire time reviewing the grading of beef shipped in from different slaughterers. Daily reports are made of their observations. Flagrant misgradings are promptly reported by wire to the supervisor in whose area the error was made. In this manner mistakes are properly and most effectively corrected. Complaints and appeals are also filed by financially interested parties to which appropriate response is made, usually by Regional Supervisors.

Finally, grade standards are considered an important part of the meat marketing system. Regardless of the supply or the demand, the matter of quality differentiation is involved. Those differentiations should be generally understood by the trade and capable of practical application. Consumers are encouraged to eat more meat when assured of a consistent quality with respect to what they believe they are buying. A sound meat

merchandizing program must be founded on uniform standards universally applied and respected.

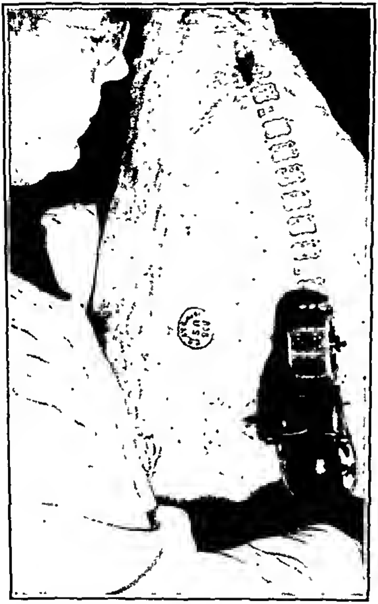

FIG. 119.—Meat grader applies the Federal grade stamp, USDA Choice, to a beef hindquarter. This purple stamp which is a harmless vegetable coloring identifies the quality of beef for packers, wholesalers, retailers and consumers. It appears on all wholesale cuts and meat retail cuts. Federal beef grades most used are Prime, Choice, Good, Commercial and Utility. Veal, calf, lamb and mutton are also graded by this non-compulsory Federal service. The round stamp to the left of the ribbon grade stamp indicates that the beef has been inspected for wholesomeness. (USDA Photo).

## Poultry

Poultry is grouped according to "kind" and "class." "Kind" refers to the different species of poultry, such as chickens, turkeys, ducks, geese, guineas, and pigeons. The kinds of poultry are divided into "classes" or groups which are essentially of the same physical characteristics, such as fryers or hens. The physical characteristics are associated with age and sex.

The kinds and classes of live, dressed, and ready-to-cook poultry listed

in the U.S. Classes, Standards, and Grades are in general use in all segments of the poultry industry. They are as follows:

**Classes of Poultry.—Chickens.**—*Fryer or Broiler.*—A fryer, or broiler, is a young chicken (usually under sixteen weeks of age), of either sex, that is tender meated with soft, pliable, smooth-textured skin, and flexible breastbone cartilage.

A special type defined as "Rock Cornish Game Hen" or "Cornish Game Hen" is included in this class. Such a bird is specifically defined to be a young, immature chicken (usually five to eight weeks of age) weighing not more than 2 pounds ready-to-cook weight, which was prepared from a Cornish chicken or a Cornish chicken crossed with other breeds of chickens.

2. *Roaster.*—A roaster is a young chicken (usually under eight months of age), of either sex, that is tender meated with soft, pliable, smooth-textured skin, and breastbone cartilage that is somewhat less flexible than that of a broiler or fryer.

3. *Capon.*—A capon is an unsexed male chicken (usually under ten months of age) that is tender meated with soft, pliable, smooth-textured skin. The term "capon" refers to surgically unsexed male birds, and they will have a barely perceptible scar about ¾ to 1 inch in length near the front of and paralleling the last two ribs on the right side resulting from the incision made in the surgical removal of the reproductive organs. Young chickens which have been chemically treated with hormones (such as diethylstilbestrol) to simulate the results of caponizing (commercially known as caponettes) are not "unsexed" and are officially classed as broilers, fryers, roasters, or stags. The same would apply to "slips" or birds which have been incompletely caponized.

4. *Stag.*—A stag is a male chicken (usually under ten months of age) with coarse skin, somewhat toughened and darkened flesb, and considerable hardening of the breastbone cartilage. Stags show an intermediate condition of fleshing and a degree of maturity between that of a roaster and a cock or old rooster.

5. *Hen, or Stewing Chicken, or Fowl.*—A hen, or stewing chicken, or fowl, is a mature female chicken (usually more than ten months of age) with meat less tender than that of a roaster and with a nonflexible breastbone.

6. *Cock, or Old Rooster.*—A cock, or old rooster, is a mature male chicken, with coarse skin, toughened and darkened meat, and hardened breastbone.

**Turkeys.**—1. *Fryer or Roaster.*—A fryer, or roaster, is a young immature turkey (usually under sixteen weeks of age), of either sex, that is tender meated with soft, pliable, smooth-textured skin, and flexible breastbone cartilage.

2. *Young Hen Turkey.*—A young hen turkey is a young female (usually under eight months of age) that is tender meated with soft, pliable smooth-textured skin, and breastbone cartilage that is somewhat less flexible than that in a turkey fryer or roaster.

3. *Young Tom Turkey.*—A young tom turkey is a young male turkey (usually under eight months of age) that is tender meated with soft, pliable, smooth-textured skin, and breastbone cartilage that is somewhat less flexible than that in a turkey fryer or roaster.

4. *Hen Turkey.*—A hen turkey is a fully matured female turkey (usually

over ten months of age) that is less tender meated than a young hen turkey, has a hardened breastbone, and may have coarse-textured skin and patchy areas of surface fat.

5. *Tom Turkey.*—A tom turkey is a mature male turkey (usually over ten months of age) with coarse skin, toughened flesh, and hardened breastbone.

FORM OF GRADE MARK


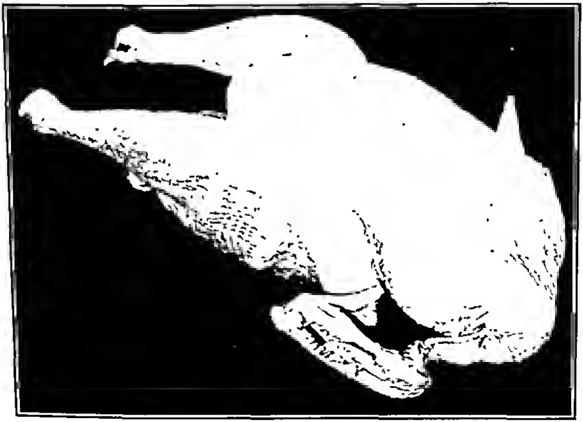

FIG. 120.—Young tom turkey—"A" quality.

**Ducks.**—1. *Broiler, or Fryer duckling.*—A broiler duckling, or fryer duckling, is a young duck (usually under eight weeks of age), of either sex, that is tender meated and has a soft bill and soft trachea.

2. *Roaster Duckling.*—A roaster duckling is a young duck (usually under sixteen weeks of age), of either sex, that is tender meated and has a bill that is not completely hardened and a trachea that is easily dented.

3. *Mature, or Old Duck.*—A mature duck, or an old duck, is a duck (usually over six months of age), of either sex, with toughened flesh, hardened bill, and hardened trachea.

**Geese.**—1. *Young Goose.*—A young goose may be of either sex, is tender meated and has a trachea that is easily dented.

2. *Mature, or Old Goose.*—A mature goose, or an old goose, may be of either sex and has toughened flesh and hardened trachea.

**Guineas.**—1. *Young Guinea.*—A young guinea may be of either sex and is tender meated.

2. *Mature, or Old Guinea.*—A mature, or an old guinea may be of either sex and has toughened flesh.

**Pigeons.**—1. *Squab.*—A squab is a young pigeon of either sex that is extra tender meated.

2. *Pigeon.*—A pigeon is a mature bird, of either sex, with coarse skin and toughened flesh.

**Standards of Quality for Live Poultry.**—Standards of quality are applicable to an individual bird. Three qualities are established for live poultry; namely, U. S. A or No. 1 Quality, or U. S. B or No. 2 Quality, and U. S. C or No. 3 Quality. Birds which fail to meet the requirements for U. S. C or No. 3 are classified as "Rejects." The specifications for the various qualities are based on the following factors:

1. Health and vigor.
2. Feathering.
3. Conformation.
4. Fleshing.
5. Fat covering.
6. Degree of freedom from defects.

**Live Poultry Grades.**—Live poultry is handled, sold, and traded commercially on the basis of lots. Since all of the birds in a lot are not likely to be the same, it is necessary that the grades permit a tolerance for some birds of a quality lower than the majority of the lot. Grades take care of these variations.

Live poultry grades are named U. S. Grade A or U. S. Grade No. 1; U. S. Grade B or U. S. Grade No. 2; and U. S. Grade C or U. S. Grade No. 3. In each of these grades, a lot of live poultry of a specified grade is required to contain at least 90 per cent, by count, of birds of the stated quality; 10 per cent may be of the next lower quality, except that U. S. Grade C is required to contain no birds below C quality.

**Standards of Quality for Dressed Poultry and Ready-to-Cook Poultry.**—The three qualities that have been established for dressed and ready-to-cook poultry, A Quality, B Quality, and C Quality, are based on the following factors:

1. Conformation.
2. Fleshing.
3. Fat covering.
4. The degree of freedom from pinfeathers and vestigial feathers.
5. The degree of freedom from discolorations of the skin and flesh, and of blemishes and bruises of the skin and flesh.
6. The degree of freedom from freezer burn.

**Sizing Poultry.**—Poultry to be marketed effectively must be sized and packaged within weight ranges which are uniform enough to meet market requirements. Squabs, for instance, are weighed on scales which reflect the

individual bird's weight at the rate of pounds per dozen. Prices are listed on this basis. Small sizes of young chickens $\frac{3}{4}$ to $3\frac{1}{2}$ pounds are packed with $\frac{1}{4}$-pound ranges. Guineas are packed in $\frac{1}{4}$-pound ranges. Their weights run mostly from $1\frac{1}{4}$ to $2\frac{1}{4}$ pounds. Fowl, capons, caponettes, roasting chickens, stags, and cocks are priced on the basis of $\frac{1}{2}$-pound ranges in weight. It has become popular to package ducks to exact weight in ounces.

Retail prices can thus be figured once for each of the 6 or 12 birds in the box. Wholesale prices for ducks generally are quoted for sizes under 5 pounds and for sizes 5 pounds and over. Turkeys and geese are packed in a range of 2 pounds. Geese weights are generally between 6 and 16 pounds. Turkeys may be found in weights as low as 4 pounds and as large as 30 pounds or over. Price listings for sizes packed in $\frac{1}{4}$-pound and $\frac{1}{2}$-pound ranges show the inside or low weight of the range. Price listings on sizes packed in a 2-pound range will show the full range, such as 4 pounds to 6 pounds.

**The Grade Mark.**—The grade mark tells the quality (U. S. Grade A, B, or C). It is usually found in combination with the inspection mark on poultry displayed in retail stores. On bulk packages, institution buyers will often find the shield grade mark separate from the inspection mark.

The shield design used as the official grade mark contains the letters "USDA" and the U. S. grade of the product, and if such information is not shown prominently elsewhere on the packaging material, the proper class of the poultry or whether it is "young" or "mature" (or "old"). In addition, one of the following phrases is included: "Graded under Federal-State supervision." "Graded under U. S. and (State) supervision," or a similar statement.

The grade mark for ready-to-cook poultry may be used only when the product is identified as having been inspected for wholesomeness by Federal inspectors or by inspectors of other inspection systems approved by the U. S. Department of Agriculture.

Chapter

# 12

## ADULTERATION AND MISREPRESENTATION

**Adulteration.**—Meat and its products during their handling and processing preparatory to being shipped to the trade may pick up or have added thereto substances that affect their wholesomeness. Also, unless appropriate inspectional control is exercised ingredients may be added to meat products which are not normal to them and therefore would not be expected by the consumer to have been used in their preparation. Furthermore, since the merchandising of meat and meat products is a commercial enterprise, there is always the temptation to substitute for one ingredient another ingredient of lesser cost or add excessive quantities of inexpensive ingredients, such as water, farinaceous materials, fat, and the like.

**Affect Wholesomeness.**—The wholesomeness of meat and meat products may be affected adversely by adulteration with contaminants such as filth, foreign substances such as fingernail polish, staples, tag fasteners, and the like, and chemicals of many kinds. The wholesomeness of meat and meat products may also be adversely affected by adulteration with materials that lower the nutritive value of the food. Adulteration with toxic ingredients obviously would make a food unwholesome.

CONTAMINATION.—*Dirt (filth).*—A great deal of emphasis has already been given in this text to the handling and preparation of meat and meat products in a way that will eliminate all diseased and otherwise unfit carcasses and parts of carcasses. In the chapter devoted to facilities relating to sanitation in plant operation, the field of environmental sanitation is reviewed in considerable detail to focus attention on the necessity for providing a clean environment in which meat and its products can be handled to avoid contaminating them with many kinds of dirt and filth. In addition to eliminating dirt and filth from the environment, inspection supervision guards against the adulteration of the food with decomposed or otherwise spoiled meat, meat products or other ingredients.

The materials that are added to meats during their preparation into many kinds of meat food products are examined to assure that only those that are clean and fit are used as ingredients. This refers to ingredients such as those mentioned in Chapter 9, page 277, which deals with materials added to meats.

The following has been taken from the records of the Federal Meat Inspection program that show rejections of materials intended for use as ingredients of inspected meat food products or in connection with their processing and packaging. The list is intended to show examples only and does not represent total rejection for any particular period.

| *Description of Material* | *Cause of Rejection* |
|---|---|
| Crushed red pepper | Mildew and Sour |
| Stuffed green olives | Sour |
| Barbecue sauce and brown gravy | Contamination with ammonia |
| Breading batter mix | Flour and grain mites |
| Grain (oats, barley, wheat) | Contamination with mice feces and moldy |
| Salt | Contaminated with rust |
| Corn flour | Weevils |
| Cheese | Sour |
| Frozen whole shelled eggs | Sour |
| Sausage seasoning spice mix | Discolored and contaminated with identified dirt |
| Canned diced red pimientos | Spoiled |
| Curing mixture | Contaminated by soot |
| Crushed chili peppers | Foreign material, grit, and stones |
| Cereal binder wheat flour | Infested with weevils |
| Ham spice | Contaminated by dirty water |
| Wheat flour | Infested with insect larvae |
| Ground red peppers | Infested with insect larvae |
| Dry gelatin | Contaminated with unidentified dirt |
| Ground carrots | Contained foreign material |
| Frozen whole eggs | Putrid |
| Corn syrup solids | Contaminated with soap & dust |
| Fennel seed | Contained rodent excreta, soil and stone |
| Whole carrot seed | Contained soil and rodent excreta |
| Dehydrated onion powder | Contained excess foreign material |
| Light mineral oil for equipment | Kerosene-like odor |
| Barley grits for baby food | Strong odor of insecticide |
| Vegetable oil | Rancid |
| Transparent film for packaging | Strong odor |
| Hungarian paprika | Shipped in unclean, unlined burlap bags |
| Ground oregano | Mineral substance in excess of normal spice |
| Wheat flour | Contained mice feces |
| Ground allspice | Insect infested |
| White distilled vinegar | Contained unidentified dirt |
| Rice flour | Contained unidentified dirt |
| Lubricating oil | Contained lithium |
| Glue for pasting labels | Contained objectionable odor |
| Small macaroni | Infested with small bugs |
| Pistachio nuts | Weevil infested |
| Steam boiler treatment compound | Contained caustic soda and tannins of vegetable origin |
| Whipped butter | Rancid |
| Chicken giblets | Spoiled |
| Chili powder | Mold |
| Cooked potatoes | Sour |
| Bacon folders | Soiled in dating machine |
| Tomato puree | Contaminated with unidentified dirt |
| Dried animal casings | Contaminated with unidentified dirt |
| Cane sugar | Vermin infested |
| Rubbed sage | Wood splinters |
| Dip for breading choppetts | Mouse contamination |
| Bay leaves | Insect webbing |
| Mace | Excess foreign material |
| Ground cumin | Contamination with unidentified dirt |
| Fresh celery | Rotten |
| Tomato paste | Excessive mold |

*Mechanical.*—Care is constantly exercised to avoid the adulteration of meat and its products with metallic particles and similar foreign material which they may pick up or which may drop into them as they progress through the meat packing plant.

The edges of shovels used in the handling of chopped and ground meat may wear thin, roll, and crumble into the meat product. This applies more particularly to shovels made of soft metals, such as cast alloys.

Staples from metal stitching machines are a dangerous source of contamination for meat. For this reason, stapling machines are not operated adjacent to exposed meat or open containers of meat. Care is exercised when opening wire bound boxes of meat to see that no loose staple becomes imbedded in the inclosed product.

Metal tag fasteners and wood and metal skewers are used in the identification and preparation of carcasses in the slaughtering department. Unless care is exercised to see that all such articles are removed from the carcass before it is taken to the cutting department, they might become imbedded in and contaminate the production of meat trimmings.

Welds are a probable source of contamination of meat with metal particles. Sometimes metal beads and pieces of slag adhere loosely to the surface of newly welded joints in the bodies of metal trucks and similar metal equipment used for handling meats. Also, particles of metal may become loosened from poor welds and become imbedded in and contaminate meat. Beads of solder may contaminate meat products in tin cans. These beads may be formed and left loosely adhering to the side of the can when the crimped edges joining the side of the can are soldered. Lacquers applied to the inside of tin cans sometimes become detached from the surface of the can after it is filled with the meat product, closed, and processed. When this occurs, the product in the can becomes adulterated with particles of lacquer.

Meat is guarded against contamination by glass from all probable sources. Light bulbs are protected when suspended directly over choppers, grinders, mixers, and similar equipment. Burned-out light bulbs are placed in rubbish containers immediately upon being removed from the electrical fixture. Milk, beverage, and other glass bottles are not brought into departments where meats are processed. Broken or cracked window panes are removed carefully and promptly from their sash and all windows are kept in a good state of repair.

Scaling paint, dust, and flaking rust are not permitted to accumulate on overhead structures. Meat and its products are not stored or handled in areas where condensation is formed on overhead structures from which it might drop into the food.

Plaster, brick dust, and particles of concrete might drop into and contaminate meat and meat products from walls or posts constructed of masonry materials and which are not protected by suitable guard rails. Particles of these materials may be dislodged by trucks or other containers of meat bumping into or scraping against the walls or posts.

Care is exercised to see that grease or oil used to lubricate trolleys, conveyor chains, and gear boxes does not drop into and contaminate meat and its products.

A great variety of miscellaneous materials such as nails and splinters from barrels and boxes used as containers of meat may contaminate the food. Particles of metal may be detached during the opening of tin cans. Even particles of wire broken from bacon hangers and belly spreaders may find their way into and contaminate meat. Considerable care is necessary to avoid contaminating meat with particles of burlap when the burlap cover is removed from slack barrels containing meat which is received at the packing plant for further processing.

FIG. 121.—Examples of ferrous particles picked up in magnet trap.

*Magnetic Trap.*—High speed hard steel grinders literally pulverize any of the typical soft metals, such as barrel nails or wire staples, which in spite of vigilance find their way into the chilled or frozen meat which is handled with such equipment. Because of the minuteness to which this foreign material is reduced, it will contaminate product throughout its processing.

The problem of trapping foreign materials is common to any food preparation industry. The nature and the extent of that care will vary with the product. In sausage and other meat food industries, the processor has to be on guard to eliminate ferrous contamination. A non-electric magnetic trap which is enclosed in a neoprene case for protection is used by the packing industry. The unit fits into the sausage stuffer between the stuffing valve and the stuffing horn. The trap is readily demounted for cleaning

and removal of the trapped articles of metal. Figure 121 illustrates metal articles removed from product by a magnetic trap.

*Chemical.—Equipment.*—The chemical composition of the surface of food handling equipment must be such that it will not adulterate the food with a chemical contaminant. Copper kettles are given a heavy protective coating of tin so that the meat or products placed in the kettles are not adulterated with copper salts. Cadmium is not used as a plating for or in the composition of metal food handling equipment. The meats or meat products placed in equipment coated with cadmium will pick up toxic quantities of the metal. Solder containing cadmium is not used.

Plastics used as coatings for food handling equipment may contain toxic chemicals that are used as plasticizers, stabilizers, or antioxidants. The use of plastic coatings containing such toxic substances is avoided since meats coming in contact with them may be contaminated with significant amounts of the toxic material.

Detergents or sanitizing agents are rinsed thoroughly from the surfaces of food handling equipment so that no residue may remain to be picked up and contaminate the meat or product which comes in contact with the improperly rinsed surface.

There are three principal forms of food contamination by metals; (1) Corrosion of the metal by the food product itself (2) electrolysis between two dissimilar metals, and (3) mechanical contamination from abrasion or wear. We are not concerned here with such metals as cadmium and lead which may produce food poisoning and are mentioned under that heading.

Alloys of aluminum and/or copper are the most common metals used in the manufacture of food processing machinery and food containers. Actually, tremendous amounts of aluminum salts are added to bakery products, and biological chemists point out that a person must assimilate significant amounts of copper and iron in his diet for good health. Nevertheless, the addition of some of these metals can contribute side effects that are undesirable in the food product. For example, iron salts cause brown or black discoloration of food, and copper salts may destroy some vitamins or break down fats or discolor the product.

Aluminum alloys will dissolve rather rapidly in both alkaline and acid solution. Also aluminum alloys tend to wear fine abrasions more quickly as compared with other materials. From tbe standpoint of electrolysis, aluminum is one of the most serious elements to consider when the aluminum comes in contact with other metals. An aluminum alloy placed against any copper alloy immediately forms a battery and sets up an electric current dissolving one of the metals rapidly because of the electrolic action.

Common iron alloys or steel rust or corrode so rapidly in contact with certain food products that they are usually considered to be undesirable contact material. Red brass or red bronze containing approximately 85 per cent copper, 5 per cent tin, 5 per cent lead, and 5 per cent zinc is an alloy which has been used for may years as a bearing material. It is undesirable for use in contact with food products because of its rapid corrosion on contact with most foods, and its softness which contributes to mechanical contamination through abrasion and wear.

Yellow brass contains approximately 70 per cent copper and 30 per cent

zinc. This metal corrodes rapidly in many food products. It is soft and has a low tensile strength. It is unsatisfactory for use in contact parts.

Aluminum bronze contains approximately 10 per cent aluminum, 2 per cent iron, and the balance copper. This material has fairly good corrosive resistant property and it is also resistant to abrasions, having high tensile strength. Adding 5 per cent nickle to this combination improves the corrosion resistant property.

There is a manganese bronze which contains about 55 per cent copper, 40 per cent zinc and a small amount of iron, manganese, and aluminum. This has a tensile strength equal to steel. The abrasion resistance is good. The corrosion resistance is excellent and there are very few food products that will remove copper from this material.

Manganese bronze can be considered a most desirable copper alloy for use as contact material in most food products. It resembles yellow brass and may be mistaken for this inferior alloy.

Many food products have a low concentration of various acids and salts that do not corrode equipment under ordinary usage. If the water is permitted to evaporate from these solutions of salts and acids, they will become so concentrated that they will produce corrosion. In addition many sugars and acids in their normal state will not corrode machine parts, but the air will oxidize them and form compounds that are highly corrosive. This emphasizes the importance of thoroughly cleaning equipment after an operation period is completed. Large quantities of water should be run through the equipment in order to dissolve away sugars, salts, or acids that may have accumulated during the processing operation.

*Containers, Wrappers, and so forth.*—Fast colors and inks are used in coloring and printing wrappers used for packaging meats. Unless the color is fast it may run and contaminate the meat in the package.

Care is exercised to see that plasticizers, antioxidants and stabilizers used in plastic wrapping materials are non-toxic since the same considerations apply as with the use of plastic coatings for food handling equipment (supra).

Aluminum foil has replaced lead foil in the packaging of meat products. At one time it was a common practice to package bouillon cubes in lead foil. This practice was discontinued to avoid the probability of adulterating the cube with lead contaminant. It is necessary to give some attention to this item because aluminum foil is not quite as suitable as a packaging material as lead foil. This is because aluminum foil tends to spring open after it is folded while there is no spring to lead foil.

*Lead Seals.*—It is the practice, principally in identifying kosher products, to attach what is called a lead and wire seal to the product. This sealing device consists of a wire having a metal disk on one end perforated for the insertion of the loose end of the wire. Before the loose end of the wire is inserted into the metal disk, it is passed through the piece of meat to be identified. After the end of the wire is inserted into the metal disk, pressure is applied to the disk and both ends of the wire are secured in it. Aluminum has been substituted for lead as the metal in the disk. Lead responds better to pressure than aluminum and it is preferred for this purpose. However,

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since the disk comes in direct contact with the meat, it is objectionable as being a probable source of lead contamination of the food.

*Pesticides.*—Meat may be contaminated with chemicals brought into the animal on its food in the form of pesticides applied to forage. Chemicals may also enter the body through the skin of the animal when insecticides are sprayed directly on the animal or used in dipping vats. Those that are toxic for humans are, of course, the most objectionable. These include organic phosphates and some of the chlorine compounds which include chlordane and DDT. Benzene hexachloride is objectionable for the additional reason that it imparts a disagreeable odor and taste to the food that it contaminates.

Constant attention is necessary to control the use of rodenticides and insecticides in a meat packing plant to avoid contamination of meat and meat products with these toxic chemical substances. The use of pesticides in packing plants is discussed beginning on page 205 in Chapter 7, also see Chapter 15, page 441.

*Drugs, Medicines.*—Aromatic medicinal preparations that are administered to animals a short time before slaughter sometimes can be detected when inspections are made because of an odor imparted to the meat by the medicine. Such meat is considered as being adulterated with a chemical, namely, the aromatic medicine.

Thiouracil has been used experimentally as an aid to fattening livestock. The ingestion by food animals of thiouracil carries into their carcasses a chemical contaminant that must be classed as adulteration of the meat, unless the animals have been allowed sufficient time (two days) to eliminate the chemical before slaughter.

LOWER NUTRITIVE VALUE.—Proposals are received from time to time to use mineral oils in place of food oils and fats in the preparation of meat food products. Such use of mineral oil is classed as an adulteration that affects the wholesomeness of the food to which it is added because it has no nutritive value and replaces a food fat which has nutritive value. Furthermore, it affects the wholesomeness of the food with which it is used because it tends to dissolve nutritive elements of the food such as the fat soluble vitamin and interferes with its assimilation by the body as it passes through the digestive tract.

Solutions of agar possess the physical characteristic of remaining solid at temperatures that will liquefy solutions of gelatin. For this reason, agar is occasionally proposed for use as an ingredient of a meat food product intended to be merchandised in a jellied condition. Agar is an inert substance. It has no nutritive value and passes through the digestive tract unchanged. It is considered, therefore, to be an adulterant that affects the wholesomeness of a food were it used as an ingredient. However, it is used as a packing medium. For example, a whole cooked beef tongue might be placed in a can and the spaces between the cooked tongue and the can filled with agar solution. There is, of course, no adulteration of the cooked beef tongue with agar because none of it enters the tongue. Such a canned article is labeled "Beef Tongue, Packed in Agar" and the statement of the quantity of contents on the label does not include the weight of the solution of agar that is used as a packing medium.

The precipitin reaction is used to detect horse meat as an adulterant. The preparation of satisfactory precipitating sera for use in this connection requires care and experience. A good precipitating serum should show a very definite ring formation when layered at the bottom of a 1:8000 dilution of the antigen, and no reaction with a 1:50 dilution of the sera of unrelated species.

The preparation of a satisfactory specific precipitating serum in the rabbit depends on the choice of antigen, the route of administration, and the number of injections. Alum-precipitated antigen is the most effective antigen for producing a high level of immunity. Injecting the alum-precipitated antigen intramuscularly is generally accepted as the most effective method of establishing immunity. It has been found possible regularly to produce high titer specific immune sera in rabbits by the intramuscular injection of 10 ml. of alum-precipitated antigen, equivalent to 2.5 ml. of normal serum.

Attempts to prepare specific sera for heat-denatured proteins have been unsuccessful. Some success has been experienced with lightly cooked meat, using immune sera prepared against the unheated material. The breaking point is in the neighborhood of 150° F.

The alum antigen is prepared by diluting 25 ml. of normal serum with with 80 ml. of distilled water and adding 90 ml. of a 10 per cent solution of potassium alum in distilled water. The pH is adjusted to 6.5 with 5 N NaOH and the mixture centrifuged. The deposit is twice washed with 200 ml. of 1:10,000 merthiolate saline, and the final precipitate made up to a volume of 100 ml. with 1:10,000 merthiolate saline. Ten ml. of antigen is equivalent to 2.5 ml. of serum and for intramuscular injection is given in 5 ml. amounts into each of both hind legs of the rabbit.

There is an inclination to adulterate hamburger with pork. Pork is an inappropriate ingredient in hamburger, which has been popularized as an all-beef product, and for the further reason that hamburger is quite commonly prepared for consumption by giving it only a superficial heating. Hamburger adulterated with pork, therefore, is potentially dangerous because the consumer may contract trichinosis from consuming uncooked pork.

Lebanon bologna is another all-beef product in which pork is an inappropriate ingredient. This class of sausage is also prepared without the use of fillers of any kind, such as cereal, dried skim milk, and soya flour. Although these fillers are expected by the consumer to be used within the limits of 3½ per cent in certain kinds of sausage, they are not expected to be used in any amount in lebanon bologna.

When the consumer purchases pork sausage he expects it to be prepared with pork to the exclusion of meat by-products or any other kind of meat. Neither does he expect that filler of any kind will be used in its preparation. Accordingly, such ingredients are considered inappropriate for pork sausage and, if used, are adulterants.

In fact, any sausage bearing a designation such as mettwurst or similar name that is associated with an all-meat product would be adulterated were it to contain a meat by-product or a filler of any kind. The same applies to luncheon meat.

Gums and gelatin are inappropriate ingredients of sausage products. These substances would permit the incorporation of excessive quantities of moisture in the sausage and would replace ingredients of nutritive value that are normally used to give the sausage substance and body. That is, the use of gums and gelatin would enable the meat packer to prepare a sausage with less than the expected amount of meat and other nutritive ingredients.

*Substitution.*—Pimientos are a popular ingredient of many meat food products. They are a delightful source of flavor and color in products in which they are used. Because of this popularity, meat packers desire to display the word "pimientos" on their labels. Such labeling would be appropriate only were pimientos actually used in the preparation of the meat product. Sweet red peppers are much less expensive than pimientos and their use in a meat food product contributes a flavor and color comparable to that obtained with the use of pimientos. Accordingly, there is a temptation to substitute sweet red peppers for pimientos. Where this is done in a product labeled with the word "pimientos" the substitution is regarded as an adulteration of the meat product with an unexpected ingredient.

Pepper is also a very popular flavoring in meat products. In the merchandising of certain products, this popularity is exploited by displaying the word "peppered" on the label in connection with the name of product. An article so labeled is considered as expected by the purchaser to have been prepared with natural pepper. The substitution of ground pepper shells, spice extractive or a substance such as oil of cubeb for the natural pepper in a meat product labeled to indicate the use of natural pepper is regarded as adulteration of the product with an unexpected ingredient.

Similarly, the term "spiced" is a popular one for use in connection with the name of product on labels for meat products. That designation is considered to create an expectancy on the part of the purchaser that natural spices had been used in the food. A substitution of spice extractives for natural spices in a product labeled with the term "spiced" is regarded as amounting to adulteration of the meat product.

*Excessive Quantities of Expected Ingredients.*—Water is presumed to be expected by the consumer to have been used in the preparation of a product such as sausage, luncheon meat and meat loaves. However, the consumer is entitled to expect that the amount of moisture is limited to that necessary for the preparation of a good product. Limitations on the moisture content of these products have therefore been established. For the purpose of facilitating the chopping of the meat and the blending of the ingredients, up to 3 per cent of water is permitted to be used as an ingredient of fresh sausage, luncheon meat and meat loaves. Quantities of water in excess of this amount if used in these classes of products constitute adulteration because they exceed the expectancy of the consumer. Up to 10 per cent of added water is permitted in cooked sausage and amounts in excess of this percentage constitute adulteration.

Cereal, dried skim milk and soya flour are presumed to be expected by the consumer in certain sausages, such as frankfurters, wieners, bologna, and liver sausage. Here again limitations have been established and

amounts of these fillers in excess of 3½ per cent are considered as constituting adulteration.

The consumer is presumed to expect that meat will not be adulterated with excessive quantities of curing solutions. The methods of curing that include injecting quantities of pickle directly into the meat or into its arterial system offer an opportunity to add excessive amounts of curing solution to the product. Curing practices are regulated so that the smoked, cured cuts of meat as they are distributed to the trade do not weigh more than the meat weighed before it was cured.

Because of its availability and lower cost by comparison with meat, there is a temptation to use excessive quantities of fat in preparation of such products as hamburger, deviled ham and pork sausage. Limitations on the fat content of these products have therefore been established. The consumer is presumed to expect not more than 30 per cent of beef fat in hamburger and quantities in excess of this amount are considered to be adulteration. The amount of fat in deviled ham is limited to 35 per cent, and the amount of fat in pork sausage is limited to 50 per cent.

*Odors.*—Occasionally, meat will pick up an objectionable odor from feed or the environment in which the meat is held. In the early spring, a strong garlic odor will sometimes persist in a beef carcass presumably traceable to ingestion by the animal of quantities of wild garlic. A fishy odor is sometimes detected in the carcass of an animal that had been fed quantities of fish waste. These odors are regarded as being in the nature of adulteration since the consumer does not expect such an odor in meat.

There have been instances where carcass meat hanging in the refrigerator has picked up a persistent creosote odor from tar or creosote material that has been used in the repairing of bunkers housing the refrigeration coils or the brine spray decks. Ammonia leaks in coolers have been known to impart to the meat hanging in the cooler a persistent odor of ammonia. It is presumed that the consumer does not expect such odors in meat and therefore, they amount to an adulteration.

**Off-Flavor Dectection.**—A single-sample taste test has been developed by the United States Department of Agriculture scientists. This method has been worked out to overcome defects of various direct-comparison tests. The single-sample taste test has taken the place of the triangle-difference method, for example. This latter method has been commonly used by judges who try to identify the odd sample among three presented at once.

One trouble that was experienced with direct-comparison methods is that the odd sample may identify itself by some difference in appearance or flavor unrelated to the question at issue. Another difficulty is that some kinds of off-flavor are apparent only as unpleasant after-tastes.

In the single-sample taste method, the tasters are given as much as they want of only one sample at each test. Time between tests is at least three hours. This method is based on the assumption that a foreign flavor is of no consequence, if tasters who have been selected for sensitivity cannot detect it when making a series of single adequately spaced tests in which selections are made at random. The method is more positive for the detection of off-flavors distinguished by a lingering after-taste or those that quickly fatigue the taste buds.

The single-sample taste test eliminates guessing which tends to occur in selecting the odd sample in a triangle-difference test. The sample either does or does not have a foreign flavor to the taster and the foreign flavor is indicated only if it is positively detected.

**Discoloration of Canned Meats.**—The discoloration most frequently encountered is caused by a metallic sulfide which is commonly black or dark brown. The metals responsible for the black or brown discolorations are usually iron and/or tin or a combination of iron and/or tin and copper. Ordinarily, a black discoloration will result in a canned meat product when iron in solution combines with sulfides under conditions favorable to the precipitation of iron sulfide.

Normally, when meat is processed in a plain (unenameled) can, some tin and iron go into solution. Usually, the tin becomes anodic to the steel in a relatively short time and protects the steel from further corrosion. There may be under these conditions some staining of the inside of the container with brown tin oxide or black iron oxide, but the dissolved metals are usually insufficient to produce discoloration of the meat in the can. This discoloration may, in some cases, transfer to or form on the product.

Copper appears to exercise a catalytic effect in producing iron discoloration in canned meat. Tests have demonstrated that discoloration can be produced by 40 p.p.m. of iron in the presence of 1 p.p.m. of copper, while 100 p.p.m. of iron developed no discoloration in the absence of copper.

The active sulphur which combines with the iron to form the iron sulfide is derived from the meat. It has been estimated that muscle protein contains approximately 1 per cent of sulphur, most of which is present in the amino acids cystine and methionine. The denaturation of the protein by the heat necessary for sterilizing the canned meat liberates sulfhdryls or hydrogen sulfide. This protein breakdown is considered normal and the resulting active sulphur does not produce an objectionable discoloration under most normal circumstances.

The formation of iron sulfide is favored in a canned meat of pH of 6.5 and higher. Since certain ingredients such as tripe and hog stomachs may have a pH ranging from 7.0 to 8.2, their use in a canned meat food product may be conducive to the formation of iron sulfide. Such ingredients are sometimes treated with vinegar preparatory to canning for the purpose of lowering the pH.

Other types of discoloration are encountered in canned meats as might happen by canning of product already discolored such as sausage in which the heme pigment had undergone discoloration (p. 416). Meat may also be discolored because of the presence of an excess amount of nitrite or by the presence of tannins. These discolorations as well as those produced by metallic sulfides are generally not considered to be dangerous to human health, with the exception of that produced by an excessive amount of nitrite if present in amounts exceeding 200 p.p.m. When the discoloration is limited to the inside of the container and does not affect the contents of the can, the product is entirely fit for food. When, however, the discoloration affects the contents of the can the contaminated portion is discarded.

**Misrepresentation.**—Purchasers of meat and meat products may be confused or misled concerning their purchase through misrepresentations

made on labels, by the appearance of the product itself, or by the container in which the product is packed. Food may be mislabeled in such a way as to mislead the purchaser concerning the origin of the product. Food may be offered for sale under the name of another food. Its label may misrepresent the product with respect to its composition, quality, or quantity. Also, labels bearing indefinite or vague warranties may mislead a purchaser.

A meat or meat product that is treated in such a way as to mask its inferiority amounts to a misrepresentation concerning the quality of the product as it is offered for sale. Containers in which meat or meat product are merchandised may misrepresent the product both with respect to its quantity and quality.

**Labels.**—The use of labels and labeling devices goes back into antiquity. Whenever, through the ages, the state of civilization favored trade or some degree of civilized communication, labels served the purpose of liaison between seller and buyer or carried some information required by law or both. The word "label," however, as a term used to denote a device that serves to carry information is a comparatively recent development. The use of the word appears to have grown out of a medieval practice of using ribbons attached to caps and helmets of various kinds worn by knights, and miters worn by bishops to identify them. The use of the term spread to include bands appearing on heraldic shields and mottoes on the mountings of images and statues, and the like. As trade and commerce developed during the Renaissance, various kinds of seals, symbols, and markings on goods and property came within the labeling category. Up until about 1750 or 1800, however, most of these marks seem to have been intended to accomplish only three purposes: to indicate ownership, to indicate conformity to some standard of weights and measures, or to identify the name and location of the manufacturer.

Archeologists have found interesting marks and distinctive designs placed on Egyptian and Assyrian brick and pottery dating back as far as 6000 B.C. Indications are that Egyptian wine merchants labeled their jugs with seals made from Nile mud as early as 3000 B.C. About the same time, Chinese potters placed distinctive colored marks on their products. Babylonian and Assyrian merchants used tags of clay pressed on string to label their goods. Wood, alabaster, gold and silver tags and labels have been found in the Nile mud. By 1000 B.C. Egyptian doctors were using labeled bamboo containers for their medicines and at the same time wooden labels were frequently used on mummy cases.

The use of labeling and marking became quite extensive with the development of trade and commerce during the Roman period. No doubt, various types of markings continued to be used throughout the Western world after the fall of Rome. It is presumed, however, that with the declining importance of commerce and trade during the dark ages, there was little reason or use for labeling. At this time the Arab world became a center of commerce and scientific advance where labeling continued to play an important role.

With the emergence of the Western world from the Dark Ages, expanding trade and commerce brought renewed attention to labeling. History shows

that this labeling during the 12 and 15 hundreds was concerned principally with the requirement that the weights and measures laws be observed and to identify the manufacturer. With the passage of time, the labeling feature identified with the location and name of the manufacturer underwent a transition from its original purpose of establishing responsibility in the manufacturer and seller to the earliest counterpart of our modern trademark. Many hundred of years passed, in fact, it was not until the early 1800's that trademark rights received protection under the law.

Indications are that the printed label first appeared in the 18th Century. At any rate, developments that led up to our modern labeling began at that time. The use of the label to add sales appeal to product was first exploited by the liquor and tocacco producers. This soon spread to the labeling of match boxes, medicines, and many other products. Many ingenious devices came into use, all aimed at better purchaser acceptance of the labeled product. The combination of resourcefulness and competition gave rise in many cases to false and deceptive labeling.

Ultimately, increased consumer knowledge, government regulations, and sound business sense have given labels a respected position in the merchandising of products. Since the early 1900's labeling has come under the control of several Federal laws. Examples of these are the Meat Inspection Act, the Poultry Inspection Act, the Food, Drug and Cosmetic Act, the Federal Feed Act, the Federal Insecticide, Fungicide and Rodenticide Act, the Wool Products Labeling Act, the Fur Products Labeling Act, the laws administered by the Federal Trade Commission, and laws administered by the Alcohol Tax Unit of the Treasury Department. States have their own laws regarding the labeling of foods, drugs, fertilizers, paints, bedding, prison-made goods, and the like.

**Mislabeling.**—*As to Origin.* Many countries and localities have acquired a reputation for producing certain meat products that are preferred by the consumer. In many instances there is a consumer preference for locally prepared meats. Unless the significance of a geographical term is understood by the purchaser of a product labeled with that term, he may be misled concerning the origin of the product.

On the other hand, many geographical terms have lost their significance with respect to locality and have acquired a recognized secondary meaning as referring to a kind of product. Terms such as frankfurter, bologna, vienna, wiener, braunschweiger, thuringer, and genoa have come into general usage as generic terms referring to kinds of sausage and are not considered as identifying the locality in which the sausage is prepared. The term "irish" has had long usage as identifying a kind of stew, and when used on labels for this product, is not considered as identifying the locality in which the stew was prepared.

Geographical terms that have not acquired a meaning with respect to a kind of product but have meaning only as identifying a particular locality may be misleading unless the products so labeled are, in fact, prepared in the locality represented by the geographical term. Such geographical terms have been accepted as brand names when followed with the word "Brand" appearing in the same size and style of lettering as the geographical term. In addition, a statement identifying the locality

in which the product was, in fact, prepared appears contiguous to the brand name as, for example, "Chicago Brand Bacon, Made in New York."

The terms "farm" and "country" have also been popular for use on labels for meat and its products. These terms if used without appropriate qualification on a label may also be misleading concerning the origin of the product unless it was, in fact, prepared on a farm or in the country. The word "farm" is sometimes used in the brand designation on a product that was not, in fact, prepared on a farm. When it is so used the word is qualified to read "Farm Brand" with the letters in both words appearing in the same size and style of lettering and the words are accompanied with a statement identifying the locality in which the product is prepared such as "Farm Brand Smoked Ham, Prepared in Chicago." The word "Country" is sometimes used on a label to designate a style of product that has not, in fact, been prepared in the country but is prepared in a way that resembles a product prepared in the country. In such case, the word "Country" is immediately followed by the word "Style" with both words appearing in the same size and style of lettering.

An exception to the foregoing concerning the qualified use of the word "farm" on labels is the use of the term "farmer" which has acquired meaning with respect to a particular type of summer sausage. On labels for this type of sausage the word "farmer" is regarded as being a generic term and is used without any qualifying wording such as "Brand," or "Style" or a statement identifying the locality in which the sausage so labeled was prepared.

Unless foreign-made meat products are identified as to their country of origin, they may be misrepresented to the American consumer as being of American origin. Accordingly, foreign meats are labeled to show that they are products of foreign origin, the label identifying the country of origin.

Names of persons or firms are not displayed on labels in such a way as to mislead the purchaser concerning their significance. When the firm name on a label is the name of the manufacturer or packer of the product, it may appear without qualification or may be accompanied with wording such as "Prepared by John Doe and Company." When the product is not prepared by the person or firm whose name appears on the label, such name is qualified by a phrase which reveals the connection the person or firm has with the product as, for example, "Prepared for John Smith and Co."

*Name of Product.*—Unless the name of the product on its label is the common or usual one and is appropriate for the particular product, the label may mislead the consumer who makes his purchase of the product relying on its label. Each name represents a product for which there is a standard of composition. This standard may be prescribed by regulation or it may only be found by making a study of the consumer expectancy concerning a particular product. In any case, the standards prescribed by regulation are presumed to have been promulgated only after a thorough study has been made of consumer expectancy and should represent consumer expectancy.

Names of products have flexibility to the extent that it is necessary that they include reference to optional ingredients when such ingredients are

used in the preparation of the food. For example, cereal may or may not be used in the preparation of frankfurters. Therefore, when cereal is used, the name of product includes a reference to the optional ingredient reading "Frankfurter, Cereal Added."

Names of products also have flexibility that permits adjusting them for use in connection with a limited variety of products. For example, the word "bacon" without qualification refers to the cured and smoked pork belly. When it is used in the name of product for cured and smoked pork jowl or cured and smoked pork shoulder plate, the appropriate names of products are "Pork Jowl Bacon" and "Pork Shoulder Plate Bacon," respectively.

Names of products are misleading when applied to products for which the name is not applicable. For example, a purchaser would not expect the name "Pork Sausage" to appear on a label for a product prepared with or containing beef. Beef is not an optional or expected ingredient of pork sausage and, therefore, such labeling would misrepresent the product to the customer. Names are used only on products that come within the range of their understood meaning. Beyond that range it is no longer a name but a misnomer that is not representative of any known product and may, therefore, be misleading.

Products made in imitation of other products are labeled with the word "imitation" in type of uniform size and prominence and immediately thereafter the name of the food imitated. This form of labeling is distinguished from the few instances where the word "mock" has acquired popular acceptance with respect to a particular food as, for example, "Mock Turtle Soup."

A name of product should not be associated with terms suggestive of another product. Such terms may mislead the purchaser concerning the product so labeled. For example, the designation "Picnic Ham" is inappropriate for a pork shoulder picnic because the word "Ham" in the term "Picnic Ham" may lead the purchaser to expect that the product so labeled is, in fact, a pork ham.

The term "kosher" is misleading if used on a label for a meat or meat product which had not been prepared under rabbinical supervision.

*Composition.*—Even though the name of a product on its label is appropriate for the article, the label may be misleading concerning the ingredients used in the preparation of the product. This is because there is considerable latitude in a choice of ingredients for many products. Ingredient statements are used on labels to permit the purchaser to distinguish the kinds of products based on differences in ingredients used. Unless an ingredient statement is, in fact, representative of the ingredients that went into the particular product, that statement would be misleading and misrepresent the product to the consumer. An ingredient statement is considered to be misleading if it fails to list all of the ingredients that were used in substantial amounts, and if the listing does not show the names of the ingredients arranged in the order of predominance of the ingredients based on the amounts used in the preparation of the product. Obviously, an ingredient statement that carries a declaration of only some of the ingredients

to the exclusion of others is misleading. Also, an ingredient statement that gives undue prominence to a minor ingredient may be misleading.

Illustrations appearing on labels are sometimes misleading concerning the composition of the product. Such illustrations are usually displayed for the purpose of suggesting to the purchaser a method for serving the product. Generally, such illustrations are obviously suggestions for serving in which case there should be no confusion on the part of the purchaser. Where the illustration that appears on a label as a suggestion for serving might be misleading, the phrase "Suggestion for Serving" or a comparable phrase is displayed prominently along with the illustration.

*Quality.*—It is sometimes difficult to distinguish between a superlative term that is displayed on a label that may mislead the purchaser concerning the quality of the product and a so-called innocent puff term that is presumed to be understood as such by the purchaser. In any case, terms such as "tops," best, premium, highest grade, and the like, can be qualified to limit their application to the products of a particular firm. This is accomplisbed by the simple device of preceding the superlative term witb the possessive form of the firm name reading for, example, "Swift's Premium."

Meat grading terms can also be used on a label in such a way as to be misleading concerning the quality of the meat on which the label is used. The term "Choice," for example, has meaning with respect to a specific grade of meat for which tbere is a Federal specification. Were that term to be used in connection with meat that does not conform with the grade specification, the term would be misleading.

The term "tender" is a favorite for use on labels for meat and its products. Since tenderness is a relative quality in meat, tbe term "tender" has been considered to be misleading unless used on meat that had been subjected to a specific method of processing that does, in fact, impart to the meat a tender quality. For example, the word "tender" has been used on labels for cured and smoked pork cuts that had been subjected to a relatively high degree of beating for an extended period of time. This process does, in fact, impart tenderness to tbe meat. The term has also been used on labels for carcass beef of the higher grades that has been subjected to a controlled aging process that accomplisbes a tender quality in the beef.

Terms that refer to certain qualities accomplished in tbe meat or meat product by particular metbods of preparation are misleading on labels unless the appropriate metbod has, in fact, been employed. In this connection tbe word "roasted" is considered to be appropriate for use on pork cuts only if the pork had in fact been cooked by dry beat sufficient to attain an internal temperature of at least 160°F. in tbe product and to impart to its surface a rendered out appearance characteristic of a roasted product.

Illustrations on labels may also be misleading concerning the quality of products on which the labels are used. For example, an illustration of very lean bacon on a bacon wrapper would be misleading if the bacon in the package did not possess a comparable degree of leanness. An illustration of beef stew showing a large meat content would be misleading on a label for beef stew unless it contained at least as much beef as the illustration indicated. Another example is an illustration on a container

of spaghetti with meat balls. The spaghetti with meat balls in the container should have at least as many meat balls as appear on the illustration and they should be of comparable size.

A label may be misleading even though the illustration on the label is representative of the product on which it is used. This may be the case when the illustration could represent another product of a different class and of greater value. The labeling of imitation products is probably the best example in this connection. Investigation has revealed that the purchaser is entitled to rely on the illustration of the product on a label in making a purchase. Unless there is some feature of equal prominence on a label to put the purchaser on notice that an illustration of imitation vienna sausage, for example, does not represent the genuine product, the purchaser may be misled into buying the imitation product when she expects the genuine product.

*Quantity.*—The statement of quantity of contents on a label would be misleadiog if it were not representative of the quantity of product covered by the label. Also, it may be misleading if it is stated in unaccustomed terms.

Variations incident to packing in accordance with good commercial practice are recognized as allowable. These variations should be reasonably constant for the same class of product. When the statement of the quantity of contents expresses the minimum quantity, the purchaser is entitled to expect no variations below the stated minimum with the variations above the stated minimum in accordance with good commercial practice. When the statement expresses actual quantity, variations might be expected both above and below that quantity within the limits of good commercial practice. However, the average would be expected to be not less than the quantity stated.

Generally, in the absence of common consumer usage, the statement of the quantity of contents on the label for a container of liquid is in terms of liquid measure, while the statement is in terms of avoirdupois weight if the product is solid, semi-solid, viscous, or a mixture of solid and liquid.

Illustrations on labels may be misleading concerning quantity when the label illustrates a larger number of pieces than are in the container. Labels for canned tamales are a good example in this connection and should show no more tamales on their illustrations than are actually in the container.

*Nutritive Value.*—To label a food that it is health-giving or is enriched with vitamins or minerals is an implied promise to the consumer that it contains, in addition to the normal constituents of the food, sufficient additional nutritive values to substantially contribute to the nutritional welfare of persons eating the food in customary amounts. Most natural foods contain a wide variety of needed factors in sufficient amounts. It is highly probable that a diet of unenriched foods in reasonable variety would more nearly supply all needed factors, known and unknown, than a diet of enriched foods. The labeling of foods with "health" or "enriched" claims tends to confuse and mislead consumers through creating an exaggerated impression of the benefits to be derived from the consumption of such food.

However, if the customary process of manufacturing a staple food refines it so as to remove significant quantities of nutritive factors present in the

natural product from which the food is made, and if the refined food is a suitable and efficient carrier of the factors so removed, some nutritionists advocate the restoration of such factors to the levels of the natural product as the most desirable basis of enrichment. To the extent that restoration serves to correct deficiencies of such factors, enrichment of the food is justified. Label declaration of such enrichment contains information concerning the quantity of added substance and the significance of the added factor in the diet of the consumer with respect to the amount of enriched food usually eaten.

*Warranty.*—Warranties are a common inclusion on labels as they are presumed to offer an added inducement to the prospective purchaser of a product. They may be misleading unless they offer something specifically and are clearly stated. The purchaser may be misled unless the warranty states what is being guaranteed and commits the guarantor to specific action if circumstances justify the purchaser to benefit from the warranty. An example of a good warranty is "Satisfaction Guaranteed or Your Money Refunded."

In contrast with a good warranty, the wording "Guaranteed Wholesome" is commonly seen on labels for food. This can mean nothing more than that the article is, in fact, the food identified by its label and is satisfactory to eat. This adds nothing to the usual rights that accrue to a purchaser of food. A label bearing the words "Guaranteed Wholesome" may be misleading to the purchaser in that those words appear to offer something of additional value when, in fact, they do not.

**Masking Inferiority.**—The color of uncured meat is recognized by the purchaser as being an indication of its freshness. He is accustomed to considering a bright red appearance of meat as indicating that it is freshly prepared. As the meat becomes stale this bright red color changes to a dark red, gray, or brownish red, especially that part of the meat exposed to the air. The addition of sulfite to meat that possesses the color normally associated by the purchaser with staleness restores the off color to bright red which the purchaser readily mistakes for the color of fresh meat. The sulfite radical replaces the oxygen in the metmyoglobin molecule to form a stable bright red sulfite of myoglobin.

A similar result could be accomplished by dyeing uncured meat with a bright red, coal-tar dye. For example, hamburger dyed in this manner will not develop an off color as it becomes stale and the purchaser relying on the bright red appearance of the product may be misled into buying the product on the mistaken idea that it is fresh. A convenient test for the presence of coal tar dye in hamburger is to place some of the product in water and the dye can be immediately demonstrated as it is dissolved out of the product by the water.

Preservatives may be used in a way that may mislead the purchaser of a food when they mask inferiority in the product. This is true when a preservative is used as a substitute for proper care in the handling and processing of a food.

Certain processes impart a characteristic appearance to meat as, for example, the familiar surface appearance of cured and smoked pork cuts. A ham possessing the appearance of a smoked ham would be expected by

the purchaser to have acquired that appearance through a conventional process of smoking. The purchaser of a ham that looks like a smoked ham would be misled if, in fact, the ham had not been smoked but had been given the appearance of a smoked ham either by coloring it artificially or through the use of some device other than smoking.

**Deceptive Containers.**—The container of a food may be made or shaped in a way that may mislead the purchaser concerning the amount of food in the container. The container with a false bottom is a good example in this connection.

The purchaser of a food packed in a can is entitled to expect that the amount of food in the container is reasonably represented by the size of the can. Cans that are not filled to their capacity (slack fill) may be misleading in this connection. Similarly, the use of excessive amounts of packing medium may be misleading concerning the amount of food in the container. For example, the amount of brine used in packing frankfurters in a can should be limited to that which is necessary to fill the spaces between the frankfurters and between the frankfurters and the can that are inevitable when the frankfurters are packed snugly in the can according to good commercial practice.

Food may be displayed in a glass container in a way that may mislead the purchaser concerning the quality of the product in the container. For example, sauerkraut and frankfurters may be packed in a glass container in such a way that all the frankfurters will be visible through the glass. This may mislead the purchaser who would be justified in assuming that the proportion of sauerkraut to frankfurters that he sees as the article is displayed in the glass container is representative of the entire contents of the container. He would be justified in assuming that the frankfurters are uniformly distributed throughout the sauerkraut in the container.

Chapter
# 13
## DETERIORATIVE CHANGES IN MEAT

ONLY those changes that occur in the animal or poultry tissue after death that affect its wholesomeness or fitness for food are classed under the heading of deteriorative changes. Meat is being constantly acted upon by its enzymes, bacteria and their enzymes, and the environment in which the meat is held. However, not all of the changes in meat that are influenced by these factors are deteriorative in the sense in which the term is used in this chapter. Changes in meat such as the reduction of glycogen to lactic acid and those brought about in connection with the controlled aging of meat, that are produced by enzymatic action, are beneficial. An example of a beneficial change produced by bacterial action is the tangy flavor produced in certain sausage products such as lebanon, thuringer, and in pork roll with the use of harmless bacterial starters of the acidophilus type.

**Durability Factors.**—A consideration of those factors that tend to give meat durability is a good introduction to the subject of deteriorative changes in meat.

**Species.**—Experience and some investigation has demonstrated that meats derived from the different species of food animals have different degrees of durability. Bull meat ranks highest in durability of meats. It and other beef are the most durable of meats, and mutton, veal, lamb, and pork follow in the order of lessened durability. Bull meat may show a high bacterial count without deterioration that can be detected organoleptically, whereas pork may show organoleptic changes under the same environmental conditions and with the same bacterial flora.

**pH.**—The durability of meats bears a direct relation to its acidity. Bacterial decomposition of meat has been demonstrated to progress more slowly in meat having a pH of approximately 6.0 or lower than in meat of a high pH. Investigations show that meats in cure which have an acidity lower than pH 6.0 provide an environment that inhibits the growth of bacteria that cause souring in meats of a higher pH. Likewise, comparisons have been made as to the keeping time before sliming of cured meats of different pH below the 6.0 level with the finding that the meats of the higher pH developed slime under the same environment sooner than those having a lower pH.

**Environment.**—*Temperature.*—At temperatures just above freezing, meat retains its fresh characteristics for a period of time sufficient to permit its distribution through the channels of trade to the consumer without significant deteriorative change. At temperatures low enough to freeze the meat to a solid condition throughout, it will keep without significant deteriorative change for periods up to six months.

Durability is also given to meat by heating it to temperatures sufficiently high to destroy its enzymes and the miscellaneous bacteria that inevitably are present. Since the cooking of meat causes it to pass through a wide range of temperatures, including temperatures that favor the growth of meat spoilage bacteria, the heating of the meat and the chilling of the meat after cooking should cause it to pass rapidly through the critical range of temperatures that favor these organisms if deteriorative changes in the meat are to be avoided. This critical temperature range lies between 60° and 115°F.

*Humidity.*—Not only must meat be held at temperatures which inhibit the growth of spoilage organisms, but the surface of the meat must be maintained as dry as possible to check the growth of organisms which have become adapted to the cold environment but need moisture to promote their growth. The humidity in the air of refrigrators is adjusted to avoid the development of a moist condition on the surface of the meat; and in the handling of the chilled meat in its distribution to the trade, care is taken to avoid exposing it to warm air from which moisture would be precipitated on the cold surface of the meat.

*Cleanliness.*—Meat that has been produced under clean conditions, with care being exercised to reduce its chance bacterial contamination to a minimum, has better keeping qualities than meat which has been produced in an unclean manner. This is recognized in manuals for meat canning where it has been found by experience that meats which are intended for canning must be kept scrupulously clean to assure satisfactory stabilizing results when certain methods of heat processing are used.

**Ingredients.**—*Salt.*—Since salt is so widely used in the preparation of many kinds of meat products, considerable investigation has been conducted to determine its effect on the stability of the product in which it is used. Most investigators have found that salt is not a bactericide in the concentrations in which it is used in meats but that it exercises a preservative effect through its inhibitory action on many species of bacteria. Many consider it to have the best preservative effect of any of the usual ingredients used in the curing of meats. Considerable stability is accomplished in meat cured with $3\frac{1}{2}$ per cent of salt.

*Nitrate.*—There are differences of opinion concerning the role played by nitrate in the stability given to meats by a process of curing. Recent investigations indicate that nitrate does not exercise any direct effect on bacteria themselves but appears to protect in some way the nitrogenous tissue against bacterial infection. The theory has been advanced that this is accomplished through an indirect effect in which hydroxylamine is formed during bacterial reduction of nitrates and this inactivates the catalase. This permits an accumulation of hydrogen peroxide which is extremely toxic for clostridia even in small concentrations.

*Nitrite.*—Earlier investigations gave rather inconclusive results concerning the bacteriostatic and bactericidal properties of nitrite. Recent work done in this connection identifies a definite bacteriostatic property of nitrite within certain acid ranges of pH. It has been demonstrated that .02 per cent of sodium nitrite, which is the amount of nitrite permitted to be used in the curing of meats, markedly inhibits and in certain instances

entirely prevents the growth of species of the following bacterial genera at pH 5.7 to 6.0: achromobacter, flavobacterium, pseudomonas, eschericheria, micrococcus, and aerobacter. The mechanism by which sodium nitrite inhibits bacterial growth has not been identified but it is known to act in a bacteriostatic capacity and probably even as a bactericide, depending on such conditions as concentration employed, pH, sensitivity of the bacteria cells, and length of exposure.

*Acetic Acid.*—Vinegar since early times has been added to food for its preservative value as well as for its flavoring qualities. The principal action of vinegar on bacteria is due to its acetic acid content, but it has been found to possess bacteriostatic and bactericidal properties in excess of that which can be attributed to pH alone. The inhibiting and lethal effect of acetic acid and salt mixtures on microorganisms is very pronounced. Pathogenic bacteria are killed rapidly in pickle composed of 3 per cent acetic acid and 3½ per cent salt.

*Smoke.*—Experience has demonstrated that the smoking of meats reduces the total bacterial count to very low figures. This bactericidal action of the smoke is due to several of its constituents, principally creosote and formaldehyde vapors. Smoke constituents that have been absorbed by the meat during its exposure continue to exert a bactericidal action after the smoking is finished.

Not only does smoking reduce the number of surface bacteria, but it makes the fat of the smoked meat resistant to the development of rancidity. Investigations have shown that smoke enables surface fat of bacon to resist oxidation for a considerable period of time. Because of the reduction in bacterial numbers, its inhibitory effect on bacterial growth, and its increased resistance to rancidity development, smoked bacon has been found to keep sound about twice as long as unsmoked bacon under comparable conditions.

*Antioxidants.*—The durability of rendered animal fats is improved considerably by the addition of approved antioxidants (page 303). The durability of rendered animal fats varies depending on the kind of raw materials used in the rendering process and the handling to which the rendered fat has been subjected. Lard, for example, which is produced by rendering uncured pork fat, has better stability than rendered pork fat prepared from cured pork fats. The refining process, especially when it includes treating the rendered fat with diatomaceous earth and activated carbon to improve its color, reduces the stability of the fat.

**Bacterial Action.**—A consideration of the phenomenon referred to as "association" helps to give perspective in understanding bacterial spoilage. Microorganisms differ widely by comparison with each other in their growth characteristics as they respond to their surroundings. This varitaion in growth characteristics results in a selection from the actual infection on a particular food of only those microorganisms that will dominate and thrive in given environment.

Since the factors making up the environment are quite complex and are ever changing, the selection of those microorganisms that will dominate in the spoilage process of a particular food becomes very complicated. This "association" concept is not only one of the useful devices that help in the understanding of spoilage but it is a highly significant consideration

when investigations into food spoilage are undertaken. This is so particularly when research is conducted with so-called "representative strains" in the usual laboratory media and under conditions that favor accelerated growth. The usefulness of results must be carefully evaluated when research provides substitutes for too many of the variables.

The durability factors (p. 398) should not only be thought of as imparting relative degrees of stability to a food, but their significance should be recognized as they serve to influence the selection of the microorganisms that produce spoilage in a particular food. The factors that influence selection fall into three categories.

1. Factors that are inherent in the particular food (substrate) as, for example, its nutrient-composition, pH, buffer power, the bacteriostatic and fungistatic substances that naturally occur in the food, and the bacteriostatic and fungistatic substances that may be added to the food during its processing. The protein lysozyme is an example of a bacteriostatic substance naturally occurring in food. Also, some naturally occurring lipids may exercise bacteriostatic action. Examples of bacteriostatic substances that may be added to foods are woodsmoke, some of the essential oils, acetic acid, nitrate, nitrite, and salt.

The selective action of the nutrient-composition of the food is well illustrated by the "protein sparing action" of sugar. Sugar provides a readily available source of energy for bacterial growth, during the curing process for example, when such bacterial growth is at the expense of the sugar and not the protein. Furthermore, the products of the bacterial growth contribute to the stability of the cured meat by affecting changes in the pH, oxygen tension, and even by the production of bacteriostatic substances.

2. Factors that are external to the food but make up its surroundings are, for example, the nature of the bacterial contamination, water vapor pressure, temperature, and oxygen tension. Generally, under usual commercial conditions, infection of a food is not a limiting factor. The food usually has sufficient contact with natural sources of ubiquitous infection such as dust, soil, water, other food. As to the factor identified as water vapor pressure, bacteria and yeast will only grow at high humidities, while molds thrive at lower humidities. Further selection occurs among molds between those that need relatively high humidity to thrive and those that will grow at lower levels of humidity.

Molds, yeasts, and mesophylic bacteria dominate the spoilage at temperatures ranging from 15° to 25° C. Thermophylic bacteria will govern the spoilage at higher temperatures up to 70° C. At commercial refrigerator temperatures from 0° to 4° C. a few psychrophilic bacteria and specialized strains of molds will grow. The oxygen tension effects a selection from the infection with aerobes thriving at high pressures, facultative anaerobes at medium oxygen partial pressures, and anaerobes thriving under pronounced anaerobic conditions.

3. Factors that are inherent in the microorganisms themselves make up the third category and they are, rate of growth of the organism, and the phenomena of synergism and antagonism. Any retardation of growth due to suboptimal environment has been considered in 1 and 2 above. It is

well established that some microorganisms will follow a more rapid growth under optimal conditions than others.

Synergism is the term applied to the phenomenon wherein certain organisms enable others to develop or stimulate the development which already prevails. The selection of microorganisms may also be influenced by the inhibitory or antagonistic effect that the growth of one group of microorganisms may have on the development of other microorganisms.

Early phases of microbial growth have been investigated with attention being given particularly to growth intermediates as they relate to the duration of the lag phase. Filtrates from growing cultures increase the initial growth rate of organisms with those taken during the late logarithmic phase being the most effective. This effect on growth applies only to the initial growth phase and not to the rate of growth in the later phase. Early lag is a phase of greatly reduced rate of growth rather than complete absence of cell division, and the effect of addition of growth-promoting intermediates is to improve the slower rate of growth to a value approaching normal. Bacteria which show no lag may be made to do so when they have been washed prior to culturing.

Sterile filtrates from fully grown cultures when added to inoculations of microorganism remove the lag phase of their growth, because they supply the cells with relatively high concentrations of necessary growth intermediates.

Earlier studies reported that when carbon dioxide tension is adequate for normal growth of the *aerobacter aerogenes* organism, the lag period produced by the addition of pheaol to the culture is largely removed by the addition of glutamic and succinic acids which supply necessary growth intermediates for the cells. It is concluded that the earlier lag phase is governed by the rate of synthesis of essential metabolites. The lag produced by washing is interpreted that washing removes essential intermediates from the cells, just as high dilution can give rise to early lag by a similar process.

A lag phase can also be increased by rendering the medium less favorable by changes in the pH or preferential composition of nutrients, or the formation of inhibitory substances. The acidified characteristic imparted to lebanon bologna, pork roll, and certain classes of thuringer bologna through the use of harmless bacterial starter of the acidophilus type creates an environment in which many microorganisms will not grow. Certain substances formed during the growth of many microorganisms, such as alcohols and fatty acids, exert an inhibitory action on some common spoilage organisms. In addition to such commonly known antibiotics as the penicillins there are so-called protein-antagonists formed by certain strains of microorganisms that are inhibitory for strains even of the same group.

**Bacterial Action on Protein.**—The bacterial cell cannot assimilate the protein molecule. The cell is impermeable to it. The protein molecule must be broken down to peptones, polypeptides, and amino acids before the nitrogen content of the protein medium is available for use by the bacterial cell in its nitrogen metabolism. This digestion of the protein medium is achieved mainly by exoenzymes excreted into the medium by the bacterial cell. Since putrefactive species of bacteria must depend for their supply of food on the decomposition of protein, it is obviously neces-

sary that some extra-cellular mechanism be present to disrupt the protein molecule into diffusible constituents assimilable by the bacterial cell. This ability to break down protein is not shared equally by all groups of bacteria.

Although the bacterial cell is impermeable to the protein molecule, it is known to excrete into the medium nitrogenous products of high molecular weight, both proteins and polypeptides. Some of the proteins possess enzymatic properties and constitute the exoenzymes referred to in the preceding paragraph, while others possess poisonous properties and are known as toxins. Some of the latter have now been demonstrated to act as enzymes and exert their toxic action on the host by means of enzymatic attack on its vital tissues. Other toxic proteins that are excreted by bacterial cells have not been identified as enzymes and owe their toxicity to other forms of action, the mechanism of which has not been fully explained.

**Molds.**—Molds growing on meats do not produce toxins and do not cause food poisoning. Thousands of different kinds of molds have been described. They have a great ability to become variants in response to a particular environment and develop resistance against adverse conditions. Their growth reactions are as different as their number of species. Some molds require darkness, others require light, and some are indifferent to light or darkness. All molds do, however, require moisture for growth. Many species of mold are troublesome in refrigerated rooms and grow not only on the meats but also on the structural environment unless the humidity of the compartment is controlled. Proper air circulation is necessary to maintain the surface of the food, food containers, and environmental facilities in a dry condition to avoid mold growth.

Molds generally appear rather dry and fuzzy to the unaided eye. They may be white or any one of numerous colors depending on the species of mold involved. The most common colors are white, green, and black. The color is imparted by the billions of spores produced by these organisms, and it is these spores that are responsible for spreading molds from one place to another. The spores are generally produced on "stalks" of the mold which grow up from the food surface.

A vast number of mold genera and species may be involved. However, they all have many characteristics in common: (1) They are aerobic. (2) They can grow in the presence of high concentration of salt or sugar and do not require a large amount of surface moisture for growth. (3) They are readily killed by normal processing temperatures and by the ordinary sanitizing chemicals. (4) They may be able to grow at temperatures down to and slightly below 32° F., although they grow better at higher temperatures, such as 45° F.

**Spoilage.**—Meat spoilage in terms of putrefactive change develops as a result of the growth of micro-organisms which attack the tissues incident to their metabolism of growth and development. The change in the meat develops by stages from a stale condition which has little but quality significance to offensive putrefaction.

Staleness in fresh meat is usually associated with a darkening of the lean surface attributed to the oxidation of the myoglobin to metmyo-

globin. If the meat is stored in a reasonably dry environment, this dark surface will become rather parchment-like.

A slimy condition sometimes develops on the surface of processed meat as well as on fresh meats, due to heavy growth of microorganisms under favorable conditions of moisture and temperature. The slime consists of huge numbers of microorganisms themselves and not a metabolic product of the microorganisms.

The types of microorganisms responsible for surface slime are quite diverse. A study of this condition revealed more than 300 cultures of microorganisms that were isolated and identified from packages of frankfurters allowed to develop slime in a refrigerator at temperatures as low as 35° F. Of these, more than 100 were found to be lactic acid bacteria, an equal number were microbacteria, more than 70 were yeasts, and 40 were micrococci.

The early stages of slime may not be readily recognized by the average individual, it is frequently mistaken for a film of fat on the surface. The term "greasy" is often used to refer to the incipient stages of slime development. As it advances, the term "slippery" is sometimes used. This adequately describes the physical nature of the product surface. The growth of microorganisms that produce the condition of slime may progress if conditions are favorable to a degree that the decomposition changes will make the product unfit for food.

By contrast with surface spoilage of meat which is commonly experienced and easily understood, there is occasionally spoilage which obviously originates deep in the muscle tissue. This deep spoilage that sometimes occurs in improperly handled pork and beef carcasses has been the subject of some investigation. It has been suggested that the causative organisms gain access to the affected tissue as a result of post-mortem invasion from the intestinal tract. It is also believed that they may be introduced into the carcass through the stick wound at the time of bleeding and distributed through the circulatory system. Another possibility is that the spoilage organisms may be the inherent flora of the involved tissues.

Studies made of the popliteal and prescapular lymph glands of cattle support a finding that spoilage organisms might be expected to be normally present in these tissues. The organisms involved include gram-negative rods, gram-positive cocci, diphtheroids, and several types of anaerobes. The proteolytic nature of these organisms together with their ability to grow anaerobically and at a wide range of temperatures indicate that they are capable of producing deep spoilage in carcasses that are inadequately refrigerated.

Bone marrow and muscle tissue from the same beef carcasses from which the lymph nodes were obtained were found to be relatively free of bacteria.

Microbial growth producing putrefactive changes does occur deep in the tissues of large cuts of meat, such as beef rounds and pork hams. The condition known as "sour hip" that sometimes occurs around the femorotibial joint in large beef rounds results from the growth of organisms that reaches putrefactive stages before the effects of refrigeration penetrate the heavy piece of meat to retard their growth.

So-called "sour spots" also occur along the femur in pork hams. These

spots may develop as a result of one of two conditions. They may result as with the "sour hip" condition in beef rounds from the growth of spoilage organisms to the point where putrefactive changes are evident before the effects of refrigeration check the growth of the organism. The "sour spots" also occur deep in a cured ham as a result of a failure of the curing ingredients to penetrate all parts of the ham in time to check the growth of spoilage organisms.

A putrid condition sometimes develops in the bone marrow of hams and pork shoulders. The bone marrow of the femur may become putrid as a result of the growth of spoilage organisms before their growth is checked by refrigerating temperatures. This may also result because of delayed penetration of curing ingredients into the bone marrow.

Sometimes water pockets form in the bone marrow of the tibia of cured hams and the fibula of cured pork shoulder picnics. The bone marrow is sometimes exposed by the cuts that sever the feet from the ham or shoulder. The water enters the bone marrow at the time the cured hams or cured pork shoulder cuts are soaked in water preparatory to smoking. The water dilutes the curing materials in the bone marrow and when the cured pork cuts are subjected to the smoking temperatures that favor the growth of micro-organisms, putrefaction of the bone marrow occurs.

**Meat Color and Factors Affecting It.**—The concentration of pigment in the muscle cells has a very important bearing on initial color and color stability. When small amounts of pigment are present, such as in the case of the flesh of young animals, even slight changes in the pigment become apparent to the eye. Moreover, mature animals of similar ages are known to have considerable variation in the pigment content of their muscles. This can be seen by comparing the same muscles from different animals or different muscles in the same animal.

The foregoing variables as they have a bearing on the appearance of meat are influenced by still another and probably the most important factor which is the degree of oxygenation of the meat pigments. While muscle pigment possesses a marked affinity for oxygen, there are present in muscle potent reducing enzymes which quickly convert the red oxymyoglobin to the purple-red myoglobin. In the fresh unfrozen meat, the reducing enzymes are free to act while, in the frozen state, their activity is at so low a level as to be practically unimportant. It is the activity of the reducing enzymes in meat which leads to conversion of the red pigment (oxymyoglobin) to the red-brown pigment (metmyoglobin). The red-brown pigment forms more readily in the relative absence of air. It is a common experience that the portion of ground meat in contact with a solid surface such as a wrapper, for example, will become brown. In handling ground beef, it is common practice to reconvert the red-brown pigment to the red pigment by mixing a mass of ground meat having a brown exterior and holding for a short time in compacted form to permit the meat-reducing enzymes to change the red-brown pigment back to the red pigment, oxymyoglobin.

The red oxymyoglobin and the purple-red myoglobin are relatively stable in meat which is frozen and, while they do experience slow oxidation, the rate is so slow that the surface of frozen meat after several months in the freezer is still definitely red. The changes that occur in meat after

freezing are oxidative in nature with the result that the grey-brown color appears on the surface and free-fatty acids and fatty-acid peroxides develop in the fat. The color of frozen meat is a highly unreliable criterion for judgment regarding its freshness.

**Discoloration of Heme Pigment.**—The bright red heme pigments which occur as oxymyoglobin in fresh meat, nitric-oxide myoglobin in uncooked cured meat, and nitric-oxide myochromogen in cooked cured meat are changed to gray and greenish pigments by the action of bacteria that have oxidizing capacities or which produce hydrogen sulphide. This chaneg is microbial, but it is not necessarily associated with putrefaction. However, the greenish discoloration constitutes an objectionable condition even though it is not a putrefactive change or the green pigments themselves are not considered to be toxic.

The oxidative changes which convert the bright red heme pigments into gray and greenish ones are held in check when there is no free access to oxygen. This availability of oxygen may be reduced by the growth of micro-organisms that produce reducing conditions in their environment. The oxidative change may also be held in check by the catalase normally present in uncooked meat and also by the catalase that is produced incident to the growth and development of many micro-organisms.

The role of hydrogen sulphide in the production of these green compounds is somewhat involved. Hydrogen sulphide reacts with reduced myoglobin to form a purplish compound. This compound rapidly oxidizes to form a greenish compound on exposure to oxygen. When myoglobin is treated with hydrogen sulphide in the presence of oxygen, the first reaction is so transitory as to be not apparent.

The oxidative changes that result in the formation of greenish compounds from the bright red heme pigments have been shown by indirect evidence to be the result of the action of hydrogen peroxide that is produced by the growth of certain types of micro-organisms. Micro-organisms that are salt-tolerant, capable of growing at relatively low temperatures, and are catalase-negative are associated with greenish discoloration of heme pigment when, as the result of their growth on the product, there is an accumulation of hydrogen peroxide.

Whether the greenish discoloration evidences itself as a surface condition, a green ring below the surface of a sausage product, or as a green core in the sausage, apparently depends on where the oxygen concentration presents the optimum condition for this development.

Experience and investigation have demonstrated that heterofermentative lactobacilli isolated from various types of greening of cured meat products have widely different degrees of heat resistance even though they are identical in their physiological, serological, and nutritional characteristics. Those isolated from cases of surface greening have been consistently less resistant to heating than the strains isolated from cases of green cores. The less resistant strains are killed by about ten to twelve minutes at 150° F. with the more resistant strains withstanding heating at that temperature up to about one hundred and twenty minutes. This emphasizes the importance of minimizing the opportunity for inoculation of the meat product with the organism by scrupulous attention to cleanliness. It demonstrates that

too much reliance should not be placed on the heating process to avoid greening.

**Chemical Tests for Incipient Putrefaction of Meat.**—Many chemical tests have been recommended and from time to time have been employed to detect incipient putrefaction of meats. None has replaced the practical evaluation of the fitness of meat by trained persons who rely on their reactions to taste, smell, appearance, and texture. None of the chemical tests is specific for detecting harmful deteriorative changes associated with infections of pathogenic bacteria or bacterial toxins. The principal incentive for the development of a chemical test to be used as an indication of fitness for food of meat or its products is the convenience of supporting an action of food seizure by testimony showing the results of the chemical test. Some food control officials have been inconvenienced when confronted with conflicting testimony concerning organoleptic observations involving seizures of spoiled meats.

There have been many chemical and physical tests employed in efforts to demonstrate spoilage: determination of amino acids; ninhydrin color reaction; amino nitrogen determinations; ammonia production; oxygen consumption tests (B. O. D.); nitrate reduction tests; methylene blue reduction tests and tests using other redox indicators; total nitrogen; non-protein nitrogen; total creatinine nitrogen; purine nitrogen, hydrogen sulphide tests; indol and skatol determinations; carbon dioxide tests; pH; iodine absorption; peroxidase test of Okolove; volatile acids; acid-alkali balance; redox potentials; Nessler's reagent; MgO test; electrical conductivity; surface tension; ultraviolet illumination—appearance and fluorescence; cryoscopic method; succinic acid determinations; Strobecker's permanganate test; etc. Jensen (1945) says that he has employed these many methods along with bacteriological examinations and has found no correlations useful either from a public health point of view or from the standpoint of specific defect in a product. The investigations of Hillig (1949), however, indicate that both the succinic acid content and the water-insoluble fatty acid content of fish products may afford a direct measure of the extent of deterioration. In any case, it would appear that conclusive testimony with respect to the fitness of any article of food should rely on the combined information obtained from chemical, bacteriological, and toxicological tests, and the organoleptic reactions of taste, smell, appearance, and texture experienced by an expert on food technology.

**Insect Infestation.**—The ham skipper (p. 218) infests cured pork products especially hams. It sometimes occurs in dried beef and salt pork. The characteristic injury to ham and other cured and smoked pork cuts consists of eating out areas along the large muscles. These affected areas may extend to the center of the meat close to the bone. Usually very fat meat such as bacon is not extensively injured since the insect prefers connective and muscular tissue.

Ham beetles (p. 218) evidence themselves on the product by their white cocoons and are easily detected when the infestation is heavy. The appearance of these cocoons is often the first indication of the insect's presence. The adult beetles feed chiefly on the surface of the meat but the larvae bore small holes into it, preferring to burrow in the fat parts.

The larder beetle (p. 219) attacks cured meats, dried meats, and cheese. Practically all injury to the product is caused by the larvæ which burrow into products such as hams, shoulders, and sides of bacon. Although the larvæ prefer the muscular parts they will burrow in the fatty portions. Dried smoked meats in neglected storage, when infested with this insect, may be reduced to powder by continued feeding of the larvæ.

Ham mites (p. 220) multiply very rapidly on the surface of infested cured meats. Often the molted skins are so abundant that they give a brownish powdery appearance to the surface of the infested product. They seldom materially damage the meat since they do not burrow into it, however, they produce an objectionable surface condition.

Usually the cured and dried meats that are found to be infested with insects and their larvæ or ham mites are not so extensively damaged as to require condemnation of the entire product. The infested portions are trimmed generously from the uninfested portion and condemned. Infested meat is not handled in uninfested rooms or areas for fear of spreading the infestation.

**Crystals of Amino Acids.**—Occasionally, white particles are observed in the lean portion of dry cured hams that have reached the age of a year or more. These particles are made up of bundles of crystals of tyrosin, histidine or another of the amino acids which are constituents of meat protein. There is always some breaking down of meat protein during the curing of meats. When the quantity of amino acids formed during the long process of dry curing is sufficiently large and conditions of storage are favorable, these separated amino acids crystallize and collect into small visible white particles that become scattered throughout the meat. This condition does not make the meat unwholesome, neither is it an indication of parasitic infestation which is sometimes suspected.

**"Freezerburn."**—When meat is stored in a frozen condition in an atmosphere of low relative humidity, there is a rapid drying of the exposed tissue. As the drying progresses the color of the surface tends to change to a pale amber and the consistency of the surface tissue becomes dry and shriveled. This condition is caused by the evaporation of ice crystals leaving behind tiny air pockets which tend to scatter the incident light and cause the tissue to appear lighter in color. This change in the dessicated surface tissue is irreversible and it persists after the meat is thawed. The same condition develops on the surface of frozen edible organs, such as livers, kidneys, hearts, and sweetbreads, packed in containers of absorbent material, such as paper-lined wooden boxes, in freezer storage of low relative humidity.

**Vinegar Pickled Product.**—**Discolorations.**—The greenish and brownish discoloration of pickled pigs feet and pickled sausage is identified with the so-called nitrite burning. The skin of the pigs feet may present a dull greenish appearance. The lean may have a deep brownish cast. Even the pickle may have a greenish cast.

Browning of vinegar pickled sausages also is identified with nitrite burning. As explained on page 332 nitrite in an acid medium becomes very reactive with the product.

Fading is another common experience with these vinegar pickled product.

This color change is also identified with the cured meat pigment which is normally a fresh pink color produced by the right amount of nitrite in the cure. The fading may be associated with a nitrite content in the cure that is too low to unite with the total myoglobin in the product.

Fading may also be identified with prolonged storage of the pickled product which was originally adequately cured. The cured meat pigment is highly unstable particularly in the presence of air.

Black spots occur on pickled pigs feet when the vinegar concentration becomes too low for adequate preservation of the product. Occasionally, inadequate mixing of vinegar and feet occurs in the packing operation. When the strength of the vinegar, as it is mixed with the product, is too low to maintain a balance in the finished product that will have an adequate preservative effect, spoilage sets in. An incident of such spoilage is the production of hydrogen sulphide by bacteria that grow in those areas of low vinegar concentration resulting in the blackening of the product. This is a spoilage condition.

**Gas Formation.**—The use of caps in vacuum closure of jars containing pickled pigs feet and sausages creates a problem associated with gas formation. When gas is formed the caps become domed and finally lift off of the jars. There are three probable sources of the gas: (1) carbon dioxide generated from bacterial fermentation of sugars. Several of the acid-tolerant lactic acid bacteria as well as the yeasts produce carbon dioxide from sugars; (2) carbon dioxide generation from the action of acetic acid on the bones; (3) gaseous nitrogen generated from the action of nitrite on amino acids.

**Turbid Pickle.**—One of the common problems associated with vinegar pickled sausages is the development of a turbid pickle several days or weeks after the product is packed. This condition is the result of extensive bacterial growth in the pickle. It is the actual presence of these bacteria that impart the turbid appearance and white sediment in the bottom of the jar.

Turbidity development due to microbial growth in pickled pigs feet is rarely observed unless sugar is added to the vinegar pickle. In the absence of sugar, these potentially spoilage microorganisms fail to grow extensively because they are nutritionally starved.

Occasionally turbidity is observed that is not of microbial origin. This turbidity is due to an emulsion of fat and tissue fragments or proteins from the feet and is associated with overcooking, inadequate washing and holding at high temperatures. This type of turbidity usually can be differentiated from bacterial turbidity by the appearance of the product.

Stringy or ropy pickle sometimes occurs in vinegar pickled sausages. Several of the acid-tolerant lactic acid bacteria are able to synthesize copious amounts of viscous polysaccharide from cane sugar. This polysaccharide is the cause of the ropiness. It is good practice to eliminate all sugar from the sausage formula and from the pickle. Ropy pickle in pigs feet is a rarity because of the absence of cane sugar. The condition just described should not be confused with the solidifying of pickle resulting from the dissolved gelatin content.

**Deterioration of Fat.—Odor Absorption.**—Fatty tissue will absorb odors from its surroundings, and these odors may or may not be objectionable de-

pending on their character. The unpleasant "tainted" odor that develops during the spoilage of meat may be picked up by the fatty tissue of unspoiled meat that is stored in the same compartment with the spoiled meat. This unpleasant odor may carry over in the fat of the unspoiled meat even after cooking.

**"Tank Water Sour."**—Fat, rendered by injecting steam directly into it, is drawn off from the steam rendering tank with a high degree of care to avoid drawing off with the rendered fat any of the so-called tank water that separates from the fat during the rendering process. This tank water contains a high percentage of soluble proteins and residual animal tissue from which the fat was rendered. The tank water and residual animal tissue tend to settle out of the supernatant rendered fat. The rendered fat is drawn off into settling tanks where it is held in a melted condition to permit further settling out of all suspended tank water and particles of animal tissue.

Sometimes this drawing off of the rendered fat from the rendering tank and the settling of the fat is done carelessly and a substantial amount of the tank water remains suspended in the chilled rendered fat. The tank water is an ideal medium for bacterial growth which takes place under favorable conditions and decomposition of protein sets in. The presence of decomposed tank water in rendered fat produces a putrid condition in the product that is known as tank water sour.

If the decomposition of the tank water has not progressed too far or has not been of too long standing, the decomposed tank water can be removed from the rendered fat by washing it thoroughly with clean, warm water.

If the putrid condition caused by the decomposition of the tank water is of long standing or extensive in degree the fat cannot be freed of the offensive condition because of the absorption of odors and probable chemical change in the fat itself.

**Hydrolysis.**—*Fat Tissue.*—Animal fats as they occur in the tissues are invariably accompanied by enzymes capable of hydrolyzing them, that is, these lipases are capable of decomposing fats into free fatty acids and glycerol. After death of the animal, the coordinating mechanisms of the cell break down and lipase attacks the fat. The rate of hydrolysis by the lipases of the fat is usually slow at low temperatures and, under more favorable conditions, their effect is frequently overshadowed by that of lipolytic enzymes produced by bacteria. Deterioration of fat tissue by the lipases of the tissues is of secondary importance in the storage of food.

Spoilage by micro-organisms occurs readily in fatty tissues and in the large variety of prepared foods containing fat. Numerous species of molds, yeasts, and bacteria are known to produce lipolytic enzymes capable of hydrolyzing fats. In some cases the enzyme remains confined within the cell of the micro-organism but usually it diffuses into the surrounding medium and there produces extensive decomposition. Microbial lipases from different sources are probably not identical, since they appear to vary to some extent in stability to heat and in the pH required for their optimum activity. Hydrolysis of fat can be produced under both aerobic and anaerobic conditions.

Fat is not normally utilized so readily by micro-organisms as are carbo-

hydrate and protein. Nevertheless, organisms have been successfully grown on artificial media containing only fat or fatty acid and mineral salts, the latter containing an ammonium salt or a nitrate as a source of nitrogen. Probably all organisms which utilize fat produce lipase so that the first stage in the metabolic process probably consists in decomposition of the glycerides into glycerol and fatty acids. Glycerol which is water-soluble and akin structurally to the sugars is partially utilized as energy, being oxidized to carbon dioxide and water. The mechanisms by which the free fatty acids are decomposed and utilized by micro-organisms are analogous to the processes of fat metabolism in the higher animals.

*Rendered Fat.*—The lipase that occurs naturally in the fat tissue is inactivated by the heat to which the tissue is subjected during the rendering process. Furthermore, since molds, yeasts, and bacteria require moisture, nitrogenous substances, and mineral salts for their metabolism in addition to a source of carbon, these organisms are absent from pure, dry rendered fat which cannot alone support their growth. Micro-organisms inoculated into such a medium, therefore, fail to produce any chemical change and the majority soon die. Organisms and spores of some types, however, remain dormant and viable for long periods.

The rendered fats of commerce are usually almost sterile when freshly prepared. Although they are a very poor medium for growth of micro-organisms they usually contain sufficient non-fatty impurities to support some growth if stored in the presence of water or at very high atmospheric humidities. Commercial lard containing 0.3 per cent of moisture inoculated with various organisms showed growth in four weeks at 37°C., whereas dehydrated lard did not.

It is desirable that the fatty acid value of an edible rendered fat be low, because the temperature at which acrid vapors are given off when a fat is used for frying decreases quite rapidly with increase in free acid content. Even a small amount of free acid produces an appreciable reduction of the smoking temperature. The presence of free fatty acid also increases the rate of corrosion and darkening when cooking fats are heated in iron vessels.

*Flavor.*—It has long been the custom to associate deterioration in rendered fats with a high free-acid content, and the acid value has been and is still very widely used in the specifications for edible rendered fats. The usefulness of this characteristic in grading these fats undoubtedly depends in part on the fact that fats, which have been exposed to conditions leading to the production of considerable quantities of free acid, are usually also rancid. The converse, however, is by no means uniformly true in that fats, which have become rancid through atmospheric oxidation, do not necessarily show abnormally high acidities. It has been shown that free fatty acids prepared with adequate precautions against oxidative decomposition can be incorporated into neutral fats at concentrations up to 15 per cent without production of any unpleasant flavor. It has even been said that completely neutral oils or fats possess an insipid taste which is actually improved by the addition of very small amounts of free acids. This does not apply, however, to fats that contain appreciable quantities of acids of fewer than 11 carbon atoms such as milk fats and vegetable fats of the coconut palm kernel class which contain considerable proportions

of volatile acids. These volatile acids possess an unpleasant rancid odor and taste and when liberated from their glycerides by the action of lipase confer these properties on the fat. The majority of food fats, however, contain no volatile acids and hydrolysis has little direct influence on their flavor.

**Oxidation.**—Deterioration of fat through oxidation is primarily due to the combination of the unsaturated constituent of the fat with oxygen to form addition compounds. These, then, decompose into secondary products some of which are responsible for the characteristic rancid odor and flavor of oxidized fats. Oxidation of fats proceeds in the heat-treated sterile material and in the absence of appreciable amounts of water indicating that the participation of biological agents is not necessary to the process. However, there are indications that the rate of development of rancidity in the fat of animal tissue can be greatly increased by biological oxidizing systems that are either present initially in the tissue or are produced by invading micro-organisms.

The oxidation of most fats proceeds with a more or less well-defined induction period during which absorption of oxygen and changes in the palatibility either cannot be detected or are relatively small. This period frequently can be divided into two parts. The first may be prolonged with the oxidation proceeding at a slow and almost constant rate. During the second stage the velocity of the reaction increases in a logarithmic manner. The duration of the induction period is of practical importance since it determines, in many cases, the storage life of the fat or fat-containing product. Once the phase of rapid oxidation has set in, the characteristic rancid odor and flavor quickly appear.

The changes in odor and taste that are produced by oxidative rancidity vary considerably with the type of foodstuff and, to some extent, with the conditions under which rancidity has developed. When it has reached a sufficiently advanced stage, the odor frequently takes on a pungent, acrid quality. General rules cannot be given for the effect of the oxidation of fat on the flavor of the food containing it. However, the odor and flavor of the food are invariably objectionable and unpleasant.

The most commonly used methods for assessing stability or rancidity of a fat or fatty foods are the. active oxygen method, Schaal oven test, thiobarbituric acid test, carbonyl test, and peroxide value. The two tests that have been found to be most useful in determining the stability of a fat are the active oxygen method and the oven test. The AOM test is based on aging and rancidification of a fat at an accelerated rate by aeration of the fat in a tube held at a constant elevated temperature. The oven test simply exposes the fat in an oven under forced draft ventilation at a temperature of 145° F.

The oven test more nearly simulates rigorous natural storage conditions than the AOM The oven test also reveals flavors and odors other than rancidity which may be present in the fat due to its nature, faulty processing, or contamination.

*Fat Tissue and Foods Containing Fat.*—Various micro-organisms, particularly those that produce an indophenol oxidase, have been shown to accelerate the production of rancidity in fats, but it has not been estab-

lished that this is due to the action of the indophenol oxidase. The increased rate of formation of peroxides and aldehydes observed when fat oxidizes in the presence of microbial lipoxidase indicates that the accelerated auto-oxidation probably follows the normal course. However, many micro-organisms by their metabolism set up reducing conditions. The main effect of the proliferation of a mixed flora on a fatty medium is therefore to inhibit oxidation of the fat. This effect may be due either to the production of reducing substances and enzymes or simply due to the quantity of available oxygen in the system being kept sufficiently low by the biological demand of the organisms to prevent oxidation of the fat. Microbial growth does not, however, invariably inhibit oxidation. Obviously, the precise effect gained depends on, among other factors, the susceptibility of the fat to oxidation, the free access of oxygen, and the numbers and types of organisms present.

Indications are that heat-labile organic oxidative catalysts (lipoxidases) may be fairly widely distributed in fatty animal tissue. The influence of these enzymes in the development of rancidity in the fat of animal tissue has not been examined in detail but it is believed that under suitable conditions lipoxidases do function as accelerators of oxidation. Various oxidizing enzymes have been demonstrated in muscle, and an indophenol oxidase has been detected in the fatty tissues of pork. This enzyme is readily inactivated by heat, exposure to a temperature of 60°C. for five minutes being sufficient to destroy most of its activity.

Atmospheric oxidation occurs spontaneously when any material containing unsaturated fat is exposed to the air. The rate of change varies considerably with the type of fat and with the condition of storage. Although spontaneous oxidation is a factor in producing deteriorative changes in fat tissue and foods containing fat, it is of considerable more importance with respect to rendered fat, a discussion of which follows under the heading "Rendered Fat."

*Yellowing.*—Closely connected with the process of oxidation of fat in animal tissue is the phenomenon of yellowing. When dry salt pork is allowed to hang at room temperature in an atmosphere sufficiently dry to prevent spoilage by micro-organisms, the exposed surface of the fat becomes discolored. This color ranges from a cream through yellow to a deep orange-yellow in very old samples. The production of this color is apparently linked in some way with oxidation, since fat which has turned yellow always shows a high content of oxygen. Fat rendered from the fatty tissue of a hog carcass does not become yellow on oxidation. However, the characteristic yellow color can be produced in oxidized colorless lard by the addition of traces of alkali. It may be that the oxidized fat in the animal tissue is acted upon by ammonia as a product of protein decomposition in the tissue to produce the yellow color.

*Rendered Fat.*—Oxidation of dry rendered fat occurs spontaneously when exposed to the air through the action of oxygen on the unsaturated fat. A fat consists of a complex mixture of glycerides which in turn are built up from glycerol in combination with saturated and unsaturated fatty acids. Under ordinary conditions saturated fatty acids are stable in air. For example, palmitic and stearic acids have been recovered from

Egyptian rock-tombs where they were found in what is believed to be the same proportion as when they were used probably as beef tallow in cosmetics buried thousands of years ago.

The amount of oxidative change necessary to make an edible fat rancid is very small. Fatty acids in general tend to become more reactive towards oxygen as the number of double bonds in the molecule increases. Linoleic acid, for example, oxidizes much more rapidly than oleic acid under the same conditions. The pronounced variation in stability toward oxidation shown by oils and fats from different sources is almost entirely due to the differences in the proportion and degree of unsaturation of the constituent fatty acids.

Susceptibility to oxidation is also influenced to some extent by the molecular structure. It is probable that the reactivity of a fat with multiple double bonds towards oxygen may vary in some degree with the proximity of the double bond in the chain to each other and to the carboxyl group. Hydrogenation of fats results in the elimination of the double bonds in the fatty acid portion of the molecule.

*Influencing Factors.*—The reaction of an autoxidizable substance with oxygen is usually characterized by a phase of very slow change which precedes rapid oxidation. This has been referred to as the induction period. In the case of fats, several factors influence the rate of oxidation and tend to shorten the induction period.

*Temperature.*—Like all chemical reactions the rate of oxidation of a fat exposed to the air is increased by raising the temperature and decreased by reducing it. The temperature of commercial cold storage reduces the rate of deterioration of the majority of food fats maintaining them in an edible condition for long periods. Oxidation of a given fat in the absence of light and of positive catalysts has a normal temperature coefficient, but the importance of temperature becomes progressively less as the intensity of illumination or the content of active metal increases.

*Light.*—Early investigators observed that exposure of fat to light had a marked effect in accelerating the development of rancidity. Under the influence of strong illumination, the induction period which precedes rapid oxidation becomes very much reduced and may disappear completely. It has been found that the exposure of fat to light even of relatively low intensity or for limited periods may have a very pronounced effect in accelerating the development of rancidity.

*Peroxides and Ozone.*—The active constituent of oxidized fats is usually assumed to be fat peroxide or hydro-peroxide. Peroxides other than those of fat can be equally effective and organic peracids are well known as accelerators of autoxidation.

Ozone attacks unsaturated fats with the formation of ozonides which subsequently decompose in a manner very similar to that of the peroxides produced in rancidity. Moreover, ozone is a powerful oxidizing agent and a catalyst for autoxidative reactions. The susceptibility of fats to the development of rancidity is greatly increased by exposure to ozone.

*Metals.*—Cases of oxidative deterioration in fat-containing materials of many kinds are frequently traced to contamination with copper and iron. The harmful effect of metals on fats is due to the acceleration of the

normal process of oxidation. In the absence of oxygen, however, they are unable to produce rancidity. A trace of an active metal added to a fat may reduce and may almost destroy the induction period. Indications are that copper is the most active catalyst with tin and aluminum being quite inactive. Lead, iron, and zinc are intermediate in activity.

**Canned Meats.**—Unlike other meats which may be seen and handled to determine their condition, the fitness for food of meats hermetically sealed in a tin container can only be judged by the external appearance of the can. Deviations in appearance from what is referred to as a normal can are indications that the contents of the can may be unfit for food. Canned meats may become unsound because they were improperly heat processed at the time of canning or because of some fault in the container that developed during or following the canning operation.

A normal can is characterized by straight sides and slightly concave ends. Also, the food should entirely fill the inside of the container. Canned liquids, however, do not usually entirely fill the can, there being a small empty space in the head of the can. Deviations from normal in the outside appearance of the can are considered as raising suspicion concerning the fitness for food of the contents of the can. Many deviations can be explained and when there is a doubt as to the fitness for food of an entire lot of canned product it can be subjected to incubation temperatures and, following incubation, the results can be evaluated. In any case, only canned products that possess the outside characteristics of normal cans are distributed to the trade, since the purchaser has been taught to be suspicious of canned food when the container deviates from the normal, and will discriminate against such cans when purchases are made. It is important to encourage purchasers of canned goods to be discriminating so that a can of food, that has developed an unsound condition because of inadequate steam pressure cooking or of some fault in the can, will not endanger the health of a purchaser.

Studies with canned meats made by the Quartermaster Food and Container Institute at Chicago show that a considerable variation in stability characteristics might be expected. With canned beef and gravy, little change in acceptability took place during two years storage at 100° F. However, chemical changes did occur during this time including high free fatty acid values and severe corrosion of cans. Swelling of similar cans was evidenced at the end of two years. Analysis of head space gasses showed the presence of more than 40 per cent hydrogen in the swollen cans.

Canned hamburger and gravy held at elevated temperatures showed predominantly chemical changes. There were fat-hydrolysis and loss of riboflavin. The product remained acceptable for about two years at 100° F. and four years at 70° F.

Canned bacon was found less stable than many of the other canned meats. Canned bacon stored at 100° F. for six months showed definite physical deterioration. At twelve months, slice separation was all but impossible. Samples stored at 70° F. by contrast were acceptable for eighteen months but declined rapidly in acceptability between eighteen and twenty-four months. The decline in acceptability involved flavor

defects and rancidity rather than physical damage. The canned bacon was processed at pasteurizing temperatures.

**Discoloration of Product.**—Discoloration is sometimes encountered on the surface of such products as canned luncheon meat. Analytical data indicates that the discoloration results from the absorption of iron by the meat primarily at points where the tinplate is stressed in the fabrication of the can. The discoloration is most prevalent in the area of the side seam of the can and adjacent to the counter-sink in the end. The iron compound may be the hydroxide, an oxide, a sulphide or some complex organic compound.

The discoloration on the surface of canned luncheon meat has been corrected by the introduction of a small area of aluminum sheet attached to one end of the interior surface of the can. To be effective, the aluminum must be in electrical contact both with the metal of the can and its contents. The effect of the aluminum is to establish a galvanic cell within the can that retards the solution of iron. In the galvanic cell the aluminum is the anode and the iron becomes the cathode. During the reaction, some of the aluminum is changed to what is probably a hydrated oxide that adheres to the aluminum metal.

**Leakers.**—Even though the food has been thoroughly heat processed in a can that is not hermetically tight, spoilage organisms will enter the product through the opening in the can and the food in the container will decompose. Leaks in cans may result from incomplete closure through some fault of the lid or closing machine at the time the lid is clamped on the can. They also result from breaks in the tin by puncture with sharp objects due to careless handling of the canned product as it is packed and distributed to the trade. Rust spots may perforate the tin to form leakers. Also occasionally, the partial cutting of a strip around the can to permit the opening of the can with the use of a key perforates the tin plate and a leaker results.

A leaker is detected by the soiled spot on the can where the gas and some juices are expelled from the can. This is associated with a looseness of the tin which becomes separated from the food in the can because the gases that have developed in the can have eliminated the slight negative pressure (vacuum) that holds the sides and ends of the can to the enclosed food in a normal canned product. The opening that produces the leak is sometimes difficult to locate especially when there is an incomplete closure which at first sight appears to be normal or when the opening is covered by the label.

**Swellers.**—The ends of the cans containing inadequately heat-processed food become distended as a result of gas that is produced in the can by the growth of spoilage organisms. Swellers also develop from leakers in those cases where there is a pinpoint leak which permits contamination of the food in the can but becomes closed, and as the gas is produced, it does not exhaust through the pinpoint hole until much pressure has been developed which, in the meantime, distends the ends of the can.

**Flat Sour.**—Flat sour spoilage is particularly insidious since the can remains "flat." This spoilage is a characteristic decomposition change but

there is no gas produced in the can. The can, therefore, has all of the external appearances of a normal canned food.

The organisms responsible for flat sour spoilage are heat resistant, some survive processing temperatures as high as 250° F. and even this temperature must be maintained for several minutes to destroy certain of these organisms. The heating schedules usually employed in processing canned meat food products are sufficient to destroy the organisms that produce the flat sour condition. However, since there is a tendency to reduce processing temperatures and time in an effort to retain the quality of meats in cans, it is important to consider the probability of contamination of the food with flat sour organisms. The effect of initial spore concentration on destruction time of these spoilage organisms assumes significance. For example, destruction time for 45,000 spores of a flat sour organism heated at 239° F. was found to be sixty-two to sixty-five minutes while 400 spores of the same organism took only twenty-five to twenty-eight minutes.

**Overstuffed.**—Cans that have been filled with an amount of food in excess of their capacity show distended ends. This gives the can an appearance similar to a sweller.

Since any deviation from the concave position of the can ends is considered as casting suspicion on the soundness of the contents of the can, overstuffed cans are not shipped to the trade. Overstuffed cans are emptied and their contents are examined for evidence of spoilage and, if found to be fit for food, the product is disposed of as being edible.

There is a class of swellers that is frequently confused with an overstuffed condition. This happens when the gas produced by decomposition of the contents in the can remains dispersed through the product giving it a spongy consistency. The gas forces the spongy product against the ends of the can producing a sweller, however, a dull sound characteristic of an overstuffed can is produced by tapping the end of the can. There is, therefore, no certain method by which the contents of the can that appears to be overstuffed might be definitely judged to be sound without opening the can for examination of the product.

**Loose Tin.**—Sometimes canned product which has been insufficiently exhausted (p. 353) before closure is heat processed. The purpose of exhausting the can before closure is to remove all air from the contents prior to sealing the lid on the can. This assures that when the canned product is cooled after heat processing, the ends of the can will conform to the mass of product in the can, and this is usually associated with a negative pressure in the sealed can. If the canned product has not been sufficiently exhausted before closure, the can will not be held tightly to the enclosed product and loose tin develops.

Cans showing loose tin are suspicious cans, because the condition may also result from the formation of a small amount of gas due to incipient decomposition of their contents. When lots of canned products showing loose tin are incubated to ascertain the fitness for food of their contents, many of them will show distended can ends at the high incubation temperature. Determination, therefore, as to the fitness for food of the contents of this class of canned product is made after the temperature of the canned product cools to room temperature. If the distended condition of the cans

disappears on cooling, their contents are judged to be fit for food. Even though it is found after incubation to be in sound condition, this class of canned product is discriminated against in the trade because the loose tin condition gives rise to suspicion concerning the fitness of the contents for food.

**Contamination with Flood Water.**—The contamination of canned product with flood water results in deteriorative changes because the exposed cans quickly rust at those points where the protective tin coating of the tin plate is broken during the canning process. Canned product that has been inundated by flood waters is examined carefully for weaknesses that develop in the can because of corrosive conditions. All those cans that show extensive rusting or corrosion are excluded from food channels. The paper labels are removed from the cans that are considered as being safe containers for food and the containers are washed in warm soapy water using a brush where necessary to remove rust or foreign material. The canned product is then immersed in a solution of sodium hypochlorite containing not less than 100 parts per million of available chlorine. The cans are then rinsed in clean, fresh water, dried thoroughly, relacquered if necessary, and relabeled.

Chapter

# 14

# FOOD POISONING

Food poisoning may have numerous etiologies including chemicals, poisonous plants and animals, bacterial toxins, and bacterial infections. Food poisoning as discussed in this chapter and associated with meat and meat food products is usually confined to the inadvertent addition of toxic chemicals, bacterial toxins formed in the product prior to consumption, and bacterial infections resulting from the ingestion of viable pathogens with the meat and meat food products.

This chapter does not include parasitic infestations such as trichinosis and cysticercosis which are covered on pages 149 and 85. The hazard of insidious toxicity associated with the conscious addition of chemicals to foods such as flavorings, processing ingredients, and packaging devices, is dealt with in the chapter on "Chemical Additives" beginning on page 430.

Neither does this chapter include a discussion of those infections that are not ordinarily associated with food but concerning which food may sometimes serve as a vehicle for the infectious agent. These infections include bacillary dysentery, infectious hepatitis, amebic dysentery, typhoid fever, scarlet fever, and acute digestive upsets of viral etiology. These infections, of course, should not be overlooked when investigations are made of suspected food poisoning outbreaks. The mentioning of these infections serves to emphasize that the correct diagnosis and intelligent analysis of any outbreak of food poisoning requires applying to the problem the full resources of symptomatology, pathology, and epidemiology in its broadest sense, including bacteriology, virology, serology, and allied sciences.

**Chemical.**—The toxic chemicals discussed here are those which induce an early pathologic response following ingestion. This may vary from a few minutes to two hours.

Instances of cadmium poisoning have occurred when acid foods were prepared in cadmium-plated metal equipment. Such outbreaks occurred in the early 1930's when popsicle trays were coated with cadmium. The acid popsicle solution dissolved the cadmium plating and consumers of the cadmium-contaminated popsicles suffered from nausea, vomiting, cramps, and diarrhea. The symptoms began in fifteen to thirty minutes following ingestion. Although there has been no recorded instance of cadmium poisoning from the ingestion of meat products, cadmium is not permitted to be used in connection with meat-handling equipment.

Certain gray enameled cooking utensils have been a source of antimony poisoning. Metallic antimony has persisted as a residual contaminant in

the enamel of such utensils. Resulting food contamination has caused nausea and vomiting within the hour following ingestion.

The close physical resemblance of sodium fluoride to baking powder, baking soda, and flour has resulted in accidental poisonings with this chemical. As a corrective measure Federal regulations now require that insecticidal sodium fluoride be colored blue. Acute sodium flouride poisoning may result from the consumption of as little as ¼ gram resulting in nausea, vomiting, and diarrhea. The consumption of large quantities has resulted in death. The use of sodium fluoride as an ascaricide for swine does not appreciably increase the amount of flouride in the swine carcass.

Barium carbonate is another pesticide that has contaminated food. It is a rat poison and being a white powder has been mixed in error with flour. The classic case is the one involving 85 British soldiers who became sick from eating tarts prepared with the contaminated flour. Nausea, vomiting, cramps, and diarrhea occur within one to two hours.

Methyl chloride poisoning has occurred resulting from direct inhalation of the gas from a leaky refrigeration system. It is mentioned here because the poisoning may occur under circumstances that might appear to implicate food. The vomiting, convulsions, and abdominal pains resulting from the poisoning may be mistaken for symptoms of gastrointestinal intoxication. Furthermore, mental confusion, drowsiness, stupor and coma also characterize this inhalation poisoning and this may be confused with botulism.

Instances of zinc poisoning, while rare, have been associated with the consumption of acid foods such as apples which were cooked in galvanized iron kettles. The symptoms are pain in the mouth, throat, and abdomen followed by diarrhea.

The physiological effects of nitrite poisoning are well understood. Excessive nitrite intake causes a condition known generally as anoxia. The tolerance of 200 parts per million has been established for nitrites in meat. The cases involving nitrite poisoning resulted from ingesting meat containing several times this amount.

Normal body respiration requires the presence of an adequate supply of oxygen in the lungs, a sufficient amount of hemoglobin which is capable of combining with this oxygen to form oxyhemoglobin, the transportation of this oxyhemoglobin to the tissues at a rate commensurate with the needs of the tissues, and the ability of the body tissues to utilize the oxygen as it is supplied to them. Any change in this process beyond the ability of the body to compensate for it results in anoxia.

Excessive nitrite ingestion will affect the oxygen-hemoglobin combination resulting in anemic anoxia. The nitrite alters the hemoglobin in a way that interferes with its ability to transport oxygen. The hemoglobin thus altered cannot enter into the oxygen exchange function of the blood.

In addition to the general symptoms of anoxia which may include rapid pulse rate, headache, impairment of the special senses, labored breathing and delirium, the condition is also characterized by a flushed face with violent, then diminished heart action. There is severe throbbing headache, dizziness, faintness, great muscular relaxation and tremors, circulatory collapse and, if the condition progresses to a fatal termination, there is marked cyanosis.

**Bacterial.**—Identifying the causative agents of food poisoning of bacterial origin has run a difficult course. In the very nature of things, food is exposed to a wide variety of bacterial contamination. A tremendous variety of environmental conditions present a potential that staggers the imagination. There are an unlimited variety of combinations of organisms, media, oxygen tensions, temperatures, and other biological controlling phenomena.

The food poisoning outbreaks themselves almost invariably present a confused picture. Only rarely is there anything like a clear picture of cause and effect. With the exception of botulism where the symptoms are usually dramatic and characteristic, identifying the causative agent in cases of food poisoning requires materials and techniques of a kind that are not usually available to the local health official.

The establishment of a case of bacterial food poisoning must be developed from a mass of case reports that attempt to identify the causative agent in the presence of many types of organisms that might be regarded as potentially capable of producing food poisoning. Bacteria that have been implicated in food poisoning belong to types that occur widely in nature. For example, foods such as raw milk, cheese, ice cream, and many meat products are regularly consumed containing thousands of living bacteria per milliliter or gram, many of which are of direct intestinal origin. In spite of this bacterial food poisoning outbreaks occur only rarely.

**Botulism.**—This is an intoxication with the toxins of *clostridium botulinum*. There are five sero types, A, B, C, D, and E, existing in nature as sporulating saprophytes which grow freely in a great variety of organic substances, if the pH is near neutral and anaerobic conditions prevail.

A powerful toxin is a product of the growth of this organism, and this toxin attacks the motor-nerve terminals. There may be nausea, vomiting, and diarrhea preceding the development of principal and characteristic central nervous system symptoms. These symptoms are extreme weakness, dryness of the mucosa, loss of ocular accommodation, double vision, vertigo, and difficulty in swallowing. The typical onset is twelve to thirty-six hours, usually less than forty-eight hours, after ingestion of the toxin-containing food. An early onset is invariably accompanied by gastrointestinal symptoms. Once the typical neuropathic symptoms have appeared, the chances for recovery are not at all favorable, being about 30 per cent.

*Cl. botulinum* is the name of a group of rod-shaped spore-forming anaerobic bacteria producing exotoxins. The spores are among the more heat-resistant types of microorganisms. Work performed on spores of *Cl. botulinum* indicates a maximum heat resistance in the nature of four minutes at 240° F.; ten minutes at 239° F.; 32 minutes at 230° F.; 100 minutes at 221° F.; and 330 minutes at 212° F. The germination of the spores of this organism requires a higher temperature of incubation than for growth and multiplication alone. In a suitable medium, growth and toxin production occur within a few days at 68° F. when either vegetative cells or spores are inoculated. When vegetative cells are inoculated in a suitable medium held at 68° F., toxin is produced but heat-detoxified spores rarely sporulate and produce toxins at 68° F.

Although the five sero types of the organism are not universally distributed throughout the world, the organism itself has a world-wide ubiquitous

distribution. Whenever food is even slightly contaminated with soil and inadequately preserved or underprocessed in hermetically-sealed containers, the food may contain viable *Cl. botulinum* spores.

The toxins produced by the various sero types differ in stabilities. These differences in stability relate to both pH and heating temperature. In all cases, however, the toxin is destroyed by cooking at 98° C. for at least ten minutes.

Since the spores of *Cl. botulinum* are present in the soil and widespread in nature, they are undoubtedly swallowed in small amounts in dust and dirt and on uncooked fresh fruits and vegetables. Botulism does not occur in this way. If small numbers of *Cl. botulinum* organism should grow in the intestinal tract and produce small amounts of toxin, we should expect to find small amounts of anti-toxin in the serum of animals. Apparently this is not the case. Accordingly, it can be assumed that the toxin of Cl. botulinum must be ingested to produce botulism.

The toxin of *Cl. botulinum* is a true exotoxin which gives rise to characteristic symptoms when injected into animals. The specific types give rise to specific anti-toxins in the serum of immunized animals.

Foods in which *Cl. botulinum* has grown have been described as possessing a disagreeable odor or a bad taste. Such non-acid foods have been described as having a foul, rancid odor. There is no characteristic off-odor or taste produced in the various classes of food by the growth of the organism. Furthermore, it is impossible to rely upon spoilage as a safeguard against botulism, since there are varying degrees of tolerance among various individuals regarding the use of spoiled food. The majority of European strains of *Cl. botulinum* and the American type E. strain causing human botulism *are non-proteolytic and probably would give little olefactory* evidence of spoilage.

**Staphylococcus.**—In the case of staphylococcus food poisoning, the food may contain sufficient enterotoxin to produce violent illness and yet have no odor of spoilage or abnormal taste. Of all the factors that favor the production of enterotoxin by the staphylococcus, temperature is the most

suitable for toxin production. The factors required for a toxin-producing medium are not fully known.

Staphylococci grow well on cured meat. They grow in concentrations of salt and sugar that inhibit the growth of many organisms. In fact, the addition of suitable concentration of salt to the food may serve to prevent the growth of certain spoilage bacteria which would compete with the staphylococci. Some staphylococci can grow anaerobically in ground ham having 5 per cent salt and 200 p.p.m. of nitrite.

The enterotoxin is extremely heat-resistant but gradually loses its potency with prolonged boiling. Toxigenic strains of the staphylococcus are coagulase-positive, but this means little in view of the fact that in one study of stools 33 per cent of the people examined with no gastrointestinal symptoms were found to contain coagulase-positive staphylococci that were probably harmless. Phage typing is now believed to be more important than sero typing in identifying toxigenic strains, and isolation of the same phage type from the feces or vomitus of a patient and from the suspected food is more conclusive than merely discovering a toxigenic phage type in either alone.

Ordinarily the ingestion of the staphylococci as such does not cause food poisoning. The food poisoning is caused by ingesting the enterotoxin produced by the staphylococci growing in the food before it is ingested. Many food poisoning outbreaks have been caused by foods which show no definite off condition.

It has been shown that the growth of the staphylococci in atmospheres of carbon dioxide enhances toxin production. Tests indicate that all food poisoning staphylococci are coagulase-positive, however, not all coagulase-positive strains are capable of producing enterotoxin. The staphylococci can grow either in or on a food product; that is, they are facultative with respect to oxygen. They grow much better aerobically, however. The staphylococci are not putrefactive and few if any off odors are produced in foods as a result of the growth of the organism.

Strains of staphylococci are notorious in their ability to become resistant to many antibiotics employed in human therapy. In individuals recovering from a serious illness, antiobiotic resistant staphylococci strains may replace the normal indigenous flora of the alimentary tract and produce staphylococci autointoxication.

Considering the total quantity of food consumed in this country that is capable of supporting growth of the food poisoning staphylococci and the many opportunities for infection of the food with the organism, it appears that staphylococci food poisoning is an exceedingly rare occurrence. Apparently only rarely are there favorable combinations of circumstances which include initial contamination and appropriate time and temperature of incubation to afford effective enterotoxin production before the food is consumed.

Based on the evidence available, it seems to be well established that the staphylococcus food poisoning organism is primarily of human origin. Foods become contaiminated with these organisms as they are handled by humans. Air would seem to be a minor source of contamination.

Apparently the anaerobic growth of the food poisoning staphylococcus

does not occur when the pH of the food is as low as 5.5. However, aerobic growth continued until the pH was lowered to 4.8. No doubt the low pH of such products as fermented sausages explains why staphylococcus food poisoning is virtually unheard of in such food items.

Altougb the enterotoxin of the staphylococcus is quite resistant to heating, the organism itself is readily destroyed by usual cooking temperatures. For example, no surviving staphylococcus was found either in or on inoculated hams after they had been smoked to an internal temperature of 137° F.

Studies have revealed no evidence of enterotoxin production by any of the coagulase-negative strains. On the other hand, enterotoxin was produced by 9 out of 12 coagulase-positive strains of staphylococcus that were tested. The best test animal to feed or inject with potent enterotoxin appears to be the rhesus monkey. Monkeys are expensive and are not easily handled, and they are also likely to become resistant to enterotoxin after several feedings. Some workers have found that six-to eight-week old kittens are susceptible to injections of the enterotoxin intraperitoneally. Adult cats are harder to handle and seem relatively less sensitive than kittens. Staphylococcus food poisoning is probably the commonest of all food poisoning. However, the number of cases occurring annually is not known because the condition is not reportable. The symptoms differ from those of botulism; they appear more rapidly and are of shorter duration. Recovery is complete in the majority of cases.

Usually the first symptom observed is salivation which is subsequently followed by nausea, vomiting, retching, abdominal cramping of varying severity, and diarrhea. In severe cases, blood and mucous may be observed in the stool and vomitus. Headache, muscular cramping and sweating often occur if symptoms are moderately severe.

Because some individuals do not develop symptoms of food poisoning when they ingest staphylococcus enterotoxin, the question arises as to the relative susceptibility of the population. From the data it is evident, however, that few people escape illness when appreciable enterotoxin is ingested in food.

same location. There is an impressive similarity between the distribution of various salmonella found in man and in domestic animals in the same environment.

One type is found most commonly all over the world. That is the *Salmonella typhimurium*. It is isolated in the United States and Canada in 30 to 40 per cent of all outbreaks of salmonella gastroenteritis and in Great Britian in two-thirds of all salmonella outbreaks. The next most common types in the United States are *S. newport*, *S. oranienburg*, *S. cholerae-suis*, *S. anatum*, *S. montevideo*, and *S. panama*. Other types, *S. derby*, *S. manhattan*, *S. newington*, and *S. dublin*, are frequently found, and still others are isolated occasionally. For example *S. thompson* is infrequently isolated from poultry and swine in the United States and this type has rarely been recovered from humans. In England, however, it has been found frequently in outbreaks of salmonellosis in ducks, but no infection in man. *S. dublin* is a common infection of the intestinal tract of apparently healthy cattle and it appears only rarely in human infections in the United States. A number of outbreaks studied in England and Wales have been attributed to this type. The Communicable Disease Center at Atlanta, Georgia, and several other Public Health Service laboratories in the United States gladly cooperate in typing cultures.

Efforts to trace sources of infection in salmonella outbreaks are frequently laborious and unsuccessful. Even when an apparent source has been found it is often difficult to be sure it is the real source. The distribution of these bacteria is universal. The natural habitat is the intestinal tract of animals and man. Food may, however, contain the organisms because it has been contaminated at any stage of its prepartation or processing, or it may already contain them because the animal from which it came was infected with salmonella clinically or asymptomatically. Human beings infected through animals may, during illness, and for varying periods thereafter discharge pathogenic bacilli in their feces and contaminate food by handling. Of the animals that furnish meat as the major source of salmonella gastroenteritis, poultry and pork are considered to be the most frequently responsible. Investigators emphasize that salmonella is a species which can live and multiply in the intestinal tracts of a wide variety of hosts and that the potential sources of contamination of foods are many.

Salmonella infection occurs both clinically and asymptomatically. Clinically, a great variety of syndromes are caused by the organisms. A slight diarrhea, a severe enteritis, a typhoidal picture, septicemia, meningitis, osteomyelitis—in short, nearly every kind of symptom caused by microbial infection may be produced by the salmonella. Not the parasite but the variable host's susceptibility and reactability are responsible for the varied clinical manifestations.

As evidence of the potential danger from salmonella infection, the following is quoted from reports on the occurrence of outbreaks in Sweden during 1953:

July 10, 1953

"For the last two weeks Sweden has been in the throes of what looks like the worst paratyphoid epidemic since the 1945 epidemic at Helsinki, Finland. Official

statistics for the period from June 16 to 30 gave 1833 confirmed cases for all Sweden. The cases were scattered throughout the country. By June 30 there were 449 confirmed and 1900 reported cases not yet confirmed in Stockholm city alone. There have been 16 deaths officially reported, of which 15 were in the province of Kronoberg.

"The epidemic has evidently spread with explosive force because only 16 cases were officially reported during the first half of June. In several cities the hospitals are full and emergency hospitals were being readied early in July. Many patients have to be treated in their homes where some degree of isolation is attempted. The case mortality rate is stated to be about 1 per cent. The deaths are chiefly among infants and the aged as might be expected.

"The causative agent is said to be of the Salm. typhi-murium type which belongs to the paratyphoid B group. This organism is usually connected with *food poisoning*, but in view of its wide extension the infection is obviously no longer limited to the original source. Cases are almost certain to continue through the summer . . .

July 17, 1953

"The epidemic of salmonellosis due to S. typhi-murium has now been traced to a *meat packing house* in Alvesta, Kronoberg province. This establishment is one of the largest in Sweden and sends its products all over the country, having also chain stores of its own. Hence the wide distribution of the infection. *It was found that sanitary inspection had been inadequate.* Many carriers were found among the personnel and rats were numerous. There had been a strike of a month's duration in May and June and the establishment was working at top speed to catch up with lost business. Poor refrigeration is also mentioned.

"The Alvesta establishment was closed on July 4 by order of the Board of Health and an effort is being made to locate the meat products already shipped. This action should soon reduce the number of new cases. Nevertheless, it is likely that the epidemic will continue for some time due to new secondary foci . . .

July 31, 1953

"The countrywide epidemic caused by S. typhi-murium appears to be declining, but the incidence is still very high, largely due to secondary foci. The primary focus of the Alvesta meatpacking establishment and its outlets has been effectively blocked. Among other infected establishments which have been closed is an oleomargarine factory at Arboga in central Sweden. According to the official reports there were 2213 cases with 24 deaths notified from July 8 to 15, as against 4064 cases with 49 deaths during the first week of July, and 2038 cases during the second half of June. The disease has apparently not extended beyond the borders of Sweden."

**Streptococci.**—*Streptococcus faecalis* (alpha-type streptococci) has been considered by many workers as being responsible for food poisoning outbreaks when enormous numbers of the organism have been found in the suspected food. Outbreaks have been attributed to the streptococci only when they are proved to be present in large number in the incriminated food and have been identified as *streptococcus faecalis*. Perhaps only a small number of the strain possess the property of causing gastrointestinal symptoms. The species is a natural inhabitant of the intestinal tract of man and animals.

In all outbreaks enormous numbers of the organism were ingested with the implicated foods and dosage undoubtedly played a role in the initiation of illness. The incubation period from the time of eating food impregnated with *S. faecalis* to the onset of illness is longer than that of staphylococcus food poisoning outbreaks and varies from three to eighteen hours.

Symptoms are usually much milder for this type of food poisoning than in staphylococcus food poisoning. The longer incubation period may represent the period required for multiplication of the organism in the

intestinal tract before the infection is manifested. Work performed with this streptococcus indicates that it is the organism itself that produces food poisoning symptoms since culture filtrates of these organisms do not. The growth characteristics of *S. faecalis* are such that the organism may multiply readily on contaminated foods. The organism is characterized by its ability to grow fairly rapidly over a wide temperature range (10° to 45° C.). It also grows in salt concentrations up to 6.5 per cent and sometimes higher. It is also sufficiently heat resistant to survive the time and temperature of pasteurization.

**Enterococcus.**—Specific strains of *escherichia coli* have been incriminated in gastrointestinal disturbances. Pathogenic strains of *E. coli* appear to be widespread in the United States and Europe. Some of these coli types might readily find their way into food.

Massive feeding of specific strains of *E. coli* to human volunteers have in some cases succeeded in producing gastrointestinal symptoms. Nausea, stomach ache, fatigue, and occasional cramps were observed. The number of outbreaks of food poisoning which may be caused by specific strains of *E. coli* is unknown. Many reports are undependable because the method employed in identifying the causative agent did not adequately eliminate other probable infective agents.

The paracolon organisms form a large group of heterogenous coli-like organisms which have physiological characteristics unlike typical Escherichia. It is difficult to identify the role of these organisms in the production of enteric disease on account of their frequent occurrence in the intestinal tract of apparently normal persons and animals. Here as in other enteric infections the very young are the usual victims.

**Clostridium Perfringens (Welchii).**—A total of 87 outbreaks ascribed to Cl. perfringens are reported in England and Wales for the period 1949-1953. This represents a considerable increase over previous reports and comment is made that food poisoning due to this organism is underestimated in the records of those countries.

By contrast with reports from England and Wales, experience in the United States is summed up by Dack that information is needed to explain the role of Cl. perfringens as a causative agent in outbreaks of food poisoning. This bacillus has been reported in the stools of patients in epidemics of diarrhea, but since it is ubiquitous and commonly found in feces, its causative role has not been definitely established.

In view of the foregoing and because a report from England and Wales is given in rather convincing terms, that report follows:

## SOURCES OF CONTAMINATION IN BACTERIAL FOOD POISONING OUTBREAKS IN ENGLAND AND WALES, 1949-53

By

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***Cl. welchii***

In the five years there were 87 outbreaks which were ascribed to *Cl. welchii*. None was recorded before 1950 and even after that time all bacteriologists were

not examining food or feces for the organism. The incidence of food poisoning due to *Cl. welchii* therefore is underestimated in the records. The foods associated with these outbreaks were noted in 84 reports and in 81 of them meat dishes were mentioned—74 were processed and made-up meats, 4 "meat", 2 fresh meat and 1 canned meat. In the 19 outbreaks associated with processed and made-up meats in 1953 the dishes mentioned were—reheated meats (6), meat pies and pasties (6), cold meats (4), stews and made-up dishes (2) and brawn (1).

The role of certain strains of *Cl. welchii* in food poisoning was recently reported in detail by Hobbs and her colleagues who described the epidemiological and bacteriological findings in more than 25 outbreaks investigated between 1947 and 1952. In typical outbreaks the patients developed relatively mild colicky abdominal pains and diarrhea (usually without vomiting or pyrexia or other constitutional symptoms) eight to twenty-two hours after a meal of cold or warmed-up meat

BACTERIAL FOOD-POISONING

| *Causal agent* | *Interval from ingestion of food to onset of illness* | *Reservoirs of the infecting organism* | *Characteristic symptoms* |
|---|---|---|---|
| *Salmonella* (food-poisoning types) | 8-72 hours; often 8-12 hours | gastro-intestinal tract of animals | abdominal pain; diarrhoea; nausea; pyrexia; sometimes vomiting; prostration |
| *Staphylococcus* | 1-6 hours; often 2-4 hours | man (skin and nose, and cuts); animals | salivation; nausea; vomiting; abdominal pain; prostration; diarrhoea; subnormal temperature; recovery in about 24 hours |
| *Enterococcus* | 4-12 hours | gastro-intestinal tract of animals | abdominal cramps; diarrhoea; no prostration or pyrexia; rapid recovery |
| *Clostridium perfringens* | 8-22 hours | gastro-intestinal tract of animals | abdominal cramps diarrhoea; no prostration or pyrexia; rapid recovery |
| *Clostridium botulinum* | 2 hours to 8 days; often 12-48 hours | soil | difficulty in swallowing double vision; no pyrexia; in fatal cases, respiratory paralysis |

FIG 122.

which had been boiled, braised, steamed or stewed for two to three hours on the day before it was to be eaten and allowed to cool slowly overnight. From most of the suspected foods and from the feces of the patients, they obtain profuse cultures of heat-resistant strains of *Cl. welchii*. Meat-broth cultures of strains isolated from food suspected to have caused food poisoning were given to three adult volunteers; one developed acute colic and diarrhea, one had mild colic and diarrhea and the third had mild abdominal discomfort. Two "control" adults given uninoculated meat broth had no symptoms. The heat resistance of the strains is associated with their ability to form spores. It is readily demonstrable in strains from feces samples, but is less easily demonstrated when the strains come direct from foods. From the detailed epidemiological and bacteriological findings the authors concluded that these heat-resistant strains were the causal agents in the outbreaks reported. Extensive studies of the sources of infection were made. They isolated heat-resistant strains of *Cl. welchii* from feces from 2 to 5 per cent of normal persons (compared with 90 per cent of cases of food poisoning due to *Cl. welchii*), from

56 per cent of 125 batches of sewage swabs from different parts of England, from the feces of 18 per cent of 76 pigs, 15 per cent of 41 rats and mice, 2 per cent of 113 cattle, from 20 per cent of 55 specimens of raw pork and 24 per cent of 54 specimens of beef. They also isolated strains from batches of blowflies from different sources—a hospital, a butcher's shop, a fried fish shop, a slaughterhouse and a refuse-sorting depot. Heat-resistant strains of *Cl. welchii* are therefore found in a variety of reservoirs—feces of human or animal origin, slaughterhouses, sewage, flies and, presumably soil and dust. Prevention of food poisoning due to *Cl. welchii* requires that food should be protected from animal and human feces, and from flies and dust. But perhaps it is most important of all that meat dishes should either be eaten hot as soon as they are cooked or cooled quickly and refrigerated adequately. As these outbreaks are nearly always associated with reheated boiled or stewed meat, such dishes should if possible not be reheated; if they have to be, they should be taken rapidly to a temperature of 100° C. Well-roasted joints (except occasionally ones made from boned and rolled meat in which heat-penetration is difficult) are seldom implicated.

**Ptomaine Poisoning.**—This term no longer has standing as a diagnosis for food poisoning. Because of its history of use in this connection, however, it is desirable to give it some attention if for no other reason than to explain its present status and give the reason for its fall from the respectable position it occupied for a great many years.

A ptomaine has been defined as a basic organic compound that is formed by the decomposition of nitrogenous matter. The term includes a wide variety of nitrogenous compounds resulting from the decomposition of protein. Some of these compounds are not particularly toxic and none are specific in the sense that bacterial toxins are. Bacteria which are in no way pathogenic may be capable of producing ptomaines. Others which are highly pathogenic may produce few or none of this class of organic compound. The expression "ptomaine poisoning" has been abandoned because it is a misnomer which does not identify an etiological factor associated with food poisoning. Food poisoning may arise from bacterial contamination of the food, from bacterial toxins retained in it, or from the presence of one or more of a large variety of deleterious chemical compounds. The expression "ptomaine poisoning" is not appropriate for any of these.

Decomposed meat, because of its objectionable taste and odor, is rarely eaten, and in any case the products of decomposition are not necessarily toxic. Contaminated meat, on the other hand, may contain pathogenic bacteria or bacterial toxins. Decomposed meat may, of course, also contain pathogenic bacteria or bacterial toxins. Clinical diagnosis of food poisoning, when it is suspected that the food is contaminated with certain bacteria or their toxins, should be supported by epidemiologic, bacteriologic, and toxicologic investigation. A diagnosis of "ptomaine poisoning" is no substitute for this.

Chapter

# 15

## CHEMICAL ADDITIVES

Man from earliest time has been concerned with the safety of food. No doubt fatal errors taught which foods could be eaten safely. Acute poisoning highlighted the experiences that led to an evaluation of food safety in those days. Today's problem is also concerned with the more insidious hazard of chronic toxicity of foods.

No food or chemical is safe or harmless or non-toxic under all conditions of possible use. It is a relative matter. Harmlessness must be evaluated only in relation to the circumstances of use and then only by applying reasonable criteria.

Practically all food consumed today has had some chemical treatment in its production, processing, packaging or storage. Farmers use several hundred organic chemical compounds for specific applications as soil conditioners, seed-treating compounds, chemical fertilizers, insecticides, weed control agents or herbicides, fungicides, rodenticides, soil fumigants, miticides, regulators of growth and maturation, and the like. Chemical research has provided many chemicals for use in food manufacture. Among these are preservatives, mold inhibitors, fumigants, germicides, antioxidants, emulsifiers, stabilizers, extenders, artificial flavors, flavor enhancers, tenderizers, artificial colors, plasticizers, ion exchange and ion sequestering agents, vitamins, films and waxing compounds, artificial sweeteners, plastic wrappers and treated papers, anti-foaming agents, and the like. Events of recent years have given the food industries a heightened awareness of potential health hazard associated with chemical additives and a realistic appraisal by industry of its responsibilities to the consuming public.

A basic consideration in the subject of chemical additives in foods has to do with the level of hazard. The many chemicals already used in the preparation of foods are presumed to have established a level of hazard which, while it cannot be easily identified in terms of true health significance, must be regarded as being substantial.

The many chemicals already being used in foods must be considered as burdening the body metabolism. It is well known that in some cases the burden is too great, notably the sodium intake level for people with high blood pressure. But the hazard level must be considered more particularly as it relates to normal individuals. Even though the level cannot be clearly identified in terms of well being of the healthy individual, it is difficult to justify increasing the hazard materially.

The Food and Drug Law of 1938 has been interpreted as endeavoring to maintain the status quo on the hazard level. In applying the law, the Food

and Drug Administration has been said to apply a "per se doctrine". That is, no new chemical additive that is toxic to humans is permitted under the law to be used in foods.

The tolerance provision contained in the "pesticide" amendment to the Food and Drugs Act of 1938 accepts the idea that the level of hazard might be a little flexible rather than rigid. The amendment recognizes that chemicals, although toxic, might be added to foods if a safe maximum amount of the chemical in the food can be identified. This safe amount is expressed as a tolerance and in terms of parts per million.

As an added safeguard in the use of a potentially toxic chemical for which a tolerance might be identified, it is commonly held that there should be a showing of necessity for use of the new chemical. That is, the use of the chemical should be necessary to the preparation of the food. To put it another way, if the chemical is not necessary in the preparation of the food, it should not be used.

The justification for applying the "necessity" doctrine is that every safeguard should be used to assure against increasing the level of hazard. There is reason to believe that the addition of a substantial number of new chemicals in foods, especially those that are known to be toxic above tolerance levels, would inevitably raise the level of hazard. In any case, it is pointed out that the tolerance provision of law is for the purpose of permitting the development of new and improved processes for food that presumably react to the consumers' benefit. If a chemical does not contribute to this improvement, it must be considered as not being necessary for use and therefore it should not be included in the food supply.

It is also well known that when a new chemical is developed that contributes something to food preparation, there is a tendency to over-promote the use of the chemical. It tends to find its way into many foods where its contribution might be considered to be negligible and to the extent that it gets such usage, it tends to become a significant part of the human diet. Just what is a safe tolerance in many cases is difficult to identify. Obviously, the total amount in a diet is significant, and this amount is influenced by the number and kind of foods in which the chemical comes to be used.

Actually, the "necessity" doctrine cannot be applied strictly. The criterion becomes one more of usefulness. Usefulness is a more practical standard. A decision based on a finding of necessity requires or tends to require the evaluation of a number of what become rather elusive factors. The standard of usefulness is not only more practical to apply but in the long run, food processors will not continue to use a chemical in the preparation of a food unless its usefulness is clearly demonstrated.

It might be said, then, that the doctrine of "necessity" emphasizes the importance of placing an effective limitation on the use of new chemicals in food when, as a practical matter, it uses the criterion of usefulness in its application. The "necessity" doctrine keeps freshly before the control official and industry the importance of not increasing significantly the hazard level in the food supply.

In the development of our knowledge of nutrition, primary emphasis has been given to deficiencies that may occur in our diets and to ways of safe-guarding against them. Along with the application of such knowledge,

a notable reduction in dietary deficiency diseases has occurred. With decreasing need in the United States for emphasis in this direction, more effort has been devoted to the investigation of positive factors in foodstuffs that might be detrimental to health.

A group of conditions broadly termed "degenerative diseases" has assumed major importance as causes of illness and death in recent decades. The causes of these conditions are under intensive investigation, and special emphasis is being placed on the role of environmental factors.

Causal relationships between environmental factors and human disease have long interested scientists. Knowledge of such relationships underlies most advances in preventative medicine. It is not surprising, therefore, that investigators at present are trying to determine whether factors in the environment are causally related to the occurrence of cancer in man. As has been true in the study of all diseases whose causes are unknown, the elements of environment to which man is constantly or repeatedly exposed, *e.g.*, the atmosphere, water, and foodstuffs, command the greatest share of attention.

Many discussions concerning the possible relation of chemicals which may occur in foods to the occurrence of cancer of man have been held at scientific meetings, and reports of these have appeared in scientific publications. Scientists involved in discussions of food additives and cancer recognize the conjectures as such, and ascribe importance to them only insofar as they may stimulate the kind of inquiries which will help advance knowledge. The conjectural nature of the scientists' discussions has frequently been forgotten, misconstrued, or poorly stated. This has contributed to an apprehension among consumers over the safety of the food supply and to the concern of many food manufacturers over the possible loss of consumer confidence.

Knowledge about possible cancer-causing agents in foods is, in general, at the point that studies are being devised and undertaken to test such possible relationships. Years of study will be required to build definitive knowledge concerning all causes of cancer. There is a need to continue and expand the present efforts to identify any relationships which may exist between environmental factors and the occurrence of cancer in man. Measures taken to safeguard the food supply can be only as effective as our state of knowledge permits.

Actually, causal relationship is known concerning the ingestion of a substance and the subsequent development of cancer in man. Accidental repeated ingestion of "radium paint" or the use of so-called "radium water" has been followed by the development of cancer of the bone. The ingestion of certain aromatic amines such as $\beta$-naphthylamine or 4-aminodiphenyl through industrial exposure has been associated with occurrence of cancer of the bladder. Epidemiologic evidence indicates that a prolonged intake of sufficient arsenic may result in development of cancer of the skin.

The National Research Council has published the following as a guide to investigators in the field of food additive toxicity:

# PRINCIPLES AND PROCEDURES FOR EVALUATING THE SAFETY OF INTENTIONAL CHEMICAL ADDITIVES IN FOODS

A Statement Prepared by the

FOOD PROTECTION COMMITTEE

FOOD AND NUTRITION BOARD
NATIONAL ACADEMY OF SCIENCES—
NATIONAL RESEARCH COUNCIL

## GENERAL PRINCIPLES

1. A decision to use an intentional additive in foods should be based on the assurance (*a*) that it will be safe, and (*b*) that it will benefit the consumer.

2. Results of critically designed tests of the physiologic, pharmacologic, and biochemical behavior of a proposed additive made in various species of animals can provide a basis for the evaluation of the safety of a chemical additive at a specified level of intake by man. It is impossible, however, to establish absolute assurance that the additive at this level will be completely safe for all humans under all conditions.

3. Additives should be subject to continuing observation for possible deleterious effects under prolonged and varying conditions of use and should be reappraised whenever indicated by advances in knowledge.

4. The safety of an additive should be appraised in terms of the minimal level of physiologic response, of the extent of its use in foods, and of the amounts that may be eaten under all likely patterns of consumption. No substance should be added to a food if there appears to be a reasonable probability that the maximum amount likely to be consumed in the human diet will produce adverse deviations from normal physiologic function.

## BASIS OF EVALUATION

In order to judge the safety of the use of an additive in the light of these principles, information must be obtained on: (*A*) the chemical and physical properties of the additive and when possible, the forms to which it may be converted in the food product; (*B*) the biologic effects of varying dosages of the additive and its conversion products, including toxicologic, metabolic, and nutritional effects; and (*C*) the anticipated levels and patterns of consumption.

### *A*. Chemical and Physical Properties

1. The additive should be identifiable in chemical and physical terms.

2. If the additive is a mixture of chemicals, the components should be described and a reproducible composition assured by reference to physical and chemical constants.

3. There must be available methods of adequate sensitivity and accuracy for the quantitative determination of the additive in all the foods in which its use is proposed and in animal tissues and fluids. The sensitivity required is dependent upon the toxicity of the additive. As a general guide it is currently considered satisfactory if analytical recovery is within ±10 per cent when the additive occurs at levels of 10 ppm or more. If the additive occurs at levels around 0.1 ppm, analytical recovery within ±40 per cent may be acceptable.

4. Knowledge of the stability of the additive and its reactivity with the components of the foods in which it will be used is desirable.

### B. Biologic Aspects

*Toxicologic aspects.* In studies of toxicity, special attention should be given to: (1) uniformity of response within and among species; (2) rate, extent, and mode of detoxification and elimination; (3) tendency toward accumulation in the body; (4) occurrence of unusual or alarming reactions such as carcinogenesis; and (5) occurrence of sensitivity, tolerance, or idiosyncrasy in response to the compound.

Toxicity must be established in terms of generally accepted indices of injury such as structural, biochemical, and physiologic changes in specific organs or body systems. Toxicity testing is often guided by a knowledge of the chemical or physical properties of the substance at hand and of the effect of substances of similar properties or structure. Tests should be so designed as to emphasize any suspected potential of the substance for injury, in order to give as stringent a test as possible. Such considerations may influence the choice of a test animal in order to obtain information in the most sensitive species.

The dosage levels investigated should range from an absence of the additive in controls through a series of intermediate levels and through at least one producing significant effects. The material should be fed at a sufficient number of levels to determine the maximum level of no response and to indicate the nature of the response at the higher levels. These observations will allow an estimate of safety in the species under study and will serve as a basis for extrapolation to the other species. In growth studies, differences may not be interpretable unless caloric intakes are equalized or otherwise taken into account.

It is not possible to design a single program that will apply to every new additive in all its applications. As an investigation progresses, data obtained may indicate the advisability of altering the program of study as originally designed.

With the above considerations in mind, the following tests may be suggested as a program which can be reasonably expected to yield the toxicologic data needed to assess hazard.

1. *Acute oral toxicity.* The approximate lethal single oral dose should be determined in at least three species, at least one of which is a non-rodent such as the dog. This information is of value in planning studies of subacute or chronic toxicity and in the recognition of symptoms. Extension of these acute tests may occasionally be desirable.

The signs, clinical course, gross and microscopic tissue changes, and, if possible the mode of death should be described. Surviving animals should be observed until completely recovered.

2 *Subacute oral toxicity.* Results from a ninety day feeding test with ten animals of each sex at each of several feeding levels may make possible a decision as to whether the proposed use is too hazardous to warrant further toxicologic study. The information obtained may also serve as a guide in selecting feeding levels for the chronic toxicity study. The dose-response relationship should be examined.

The data sought may include, at each of the several feeding levels, the effects on food consumption, growth, mortality rate, blood and urine composition, and organs as measured by weight and histopathologic findings. Any alterations in functions and behavior should be noted. Effects on digestibility and utilization of the ration may be important.

The subacute feeding tests with rats may be so designed that enough rats are

used at each dietary level to provide animals to be continued in tests for chronic toxicity, in the event it becomes advisable to conduct such tests.

3. *Chronic oral toxicity:* Long-term tests are conducted on the premise that the possible effects of the lifetime ingestion of an additive in food by man cannot be predicted from results of tests less stringent than lifetime feeding in a shortlived animal (approximately two years in the case of the rat) and one year or longer feeding in the dog or monkey. Obviously these tests may be either inadequate to the purpose or more exacting than necessary, but past experience has not supplied a more rational alternative.

In the tests with rats the material is fed at selected levels in the diet to groups of 25 or more weanling animals of each sex. The levels to be fed should be chosen on the basis of the data obtained in the subacute feeding tests.

The two-year tests may include observations on: food consumption; growth; absorption, excretion, and tissue storage of the additive; mortality; organ weights; histopathologic and hematologic findings; blood and urine chemistry; such changes in behavior and function as may be determined by gross observation; and such other observations as may be indicated in special circumstances. Effects on ration digestibility and utilization and on reproduction and lactation may be especially significant.

For dogs or monkeys, groups of three or more animals are usually fed the material under test at three or more intake levels for one year or longer. Observations are similar to those made in the chronic feeding test with rats. The dog or monkey tests are generally started after the rat studies have been in progress long enough to provide data to aid in selecting the feeding levels likely to be most informative.

*Biochemical, metabolic, and nutritional aspects.* It is desirable to study in animals the biochemistry and the metabolic fate of additives. After animal tests have indicated reasonable safety, studies on man may be undertaken. Such studies may yield valuable information. Biochemical evidence can be of value in determining the safety of a compound by showing whether the additive is a product formed during the normal intermediary metabolism of foodstuff in the human body and whether it is metabolized by way of the well-known pathways of dietary components. This evidence can seldom entirely replace that from chronic toxicity tests. Special consideration must be given the possibility that the metabolism of the additive will overload the normal pathways for metabolism of foodstuffs.

The influence of an intentional additive upon the nutritional contribution of the foods in which it may appear must be considered. It is important to ascertain the effect of the additive on the stability of nutrients in the foods, as well as on the digestibility and utilization of the ration.

In addition to the foregoing, two special considerations should be reemphasized: (*a*) The possibility of alteration of the additive after its addition to foodstuffs should be explored. The altered additive or its reaction product with an entity of the food may be more or less toxic than the original chemical. (*b*) The extent to which chemically or pharmacologically similar substances are present in the usual diet should be known.

*C.* Anticipated Levels and Patterns of Consumption

In order to estimate the probable intake level of the additive, information on its proposed use is essential. This information includes (*a*) the amount of the additive technically desirable in foods, (*b*) the proportion of the usual diet composed of foods in which this additive may appear, and (*c*) the extremes of probable intakes of these foods. From this information the maximum potential consumption by individuals or special groups as well as the average potential consumption for the general population can be estimated.

## EVALUATION

One of the most difficult problems in the interpretation of toxicologic data is the translation of such data into terms of human use levels and margins of safety. Each substance presents problems peculiar to itself and requires individual consideration by those competent to exercise objective judgment of all the available evidence.

The decision as to a safe level for an intentional food additive should be based upon such factors as the maximum dietary level that produced no unfavorable response in test animals, the severity of response in test animals at dietary levels above the no-response level, and the estimated potential for human consumption of the food or foods for which the additive is proposed.

In attempts to predict the safety of a proposed food additive to humans in terms of toxicity in animals, the statement has been made that the additive should have at least a 100-fold margin of safety. Good pharmaceutical judgment dictates that there shall be a clear distinction between a safe dose and a toxic dose.

Animals, for the most part, are more resistant to toxic chemicals than man. This can be illustrated for two familiar substances for which some chronic toxicity data are available for the two commonly employed laboratory animals and for man. Man can ingest 1 ppm. of chlorine in his daily diet without harmful effects, whereas the rat can tolerate about 10 ppm. In experiments with sub-acute toxicity, man begins to show signs of intolerance to arsenic at about 30 ppm. in the diet whereas the dog can tolerate 127 ppm. Man is about 10 times as sensitive to poisons as the rat and somewhat more than 4 times as sensitive as the dog.

There is considerable variation in susceptibility among animal species. This susceptibility changes from one substance to another but, in general, rats are less susceptible to toxic substances than dogs and slightly more susceptible than mice.

There is variation in susceptibility within the different strains of the same species, with age within the same strain, and within different animals of the same strain, age and sex. Since the human population as a whole is heterogeneous the factors influencing susceptibility are of particular importance in assessing the human hazards.

In experimental work the animals employed are chosen from a healthy stock and are kept under controlled conditions, whereas humans vary greatly in state of health, type of diet, and all conceivable conditions of existence. Sickness increases susceptibility to toxic substances. It has been estimated that a sick individual may be as much as 10 times more susceptible to toxic substances than an individual in good health. Dietary inadequacies also influence the effects of toxic substances as does physical stress, heat, and cold. Thus, allowance must be made for these influencing factors as well as for the healthy, average individual on an adequate diet.

In the over-all consideration of the safety of the material in human use, all of the auxiliary factors that make up the diet characteristic of the human must be taken into account. The proposed additive will be only one of a number of other substances that may be unintentionally or unavoidably added to foods tending to increase the total strain on the body's catabolic mechanism. It has been shown that the effect of feeding a combination of certain insecticides in the same diet is greater than the effect of any one in the group. Even a history of long usage in man is not adequate proof of safety. Laboratory re-evaluation of such substances as lithium chloride, a salt substitute; dulcin, a synthetic sweetening agent; and coumarin, a flavor, has shown these materials to be unsuitable as additives to the human diet.

Since man can seldom be used as an experimental subject, reliance for the evaluation of the toxicity of a substance must ordinarily be placed upon studies in laboratory animals. Even then it cannot be said for certain that lack of toxicity in animals will necessarily forecast what may occur in man. However, the selection of the 100-fold margin of safety serves as a reasonable safeguard to minimize the danger.

There is an important aspect of animal experimentation that seems to be receiving increased attention, namely, the "stress group". Usually, animal experimentation is aimed at a very different target. A group of animals is selected on the basis of maximum homogeneity, and the experiment carried on with great pains to maintain the uniform animal in a uniform environment and to present one challenge, that is, the substance for treatment under investigation. It is quite obvious that such experimental conditions are designed to reduce the number of variables and make it easier to interpret results. However, it can also be said that such an experimental arrangement by its very nature may be limiting the number of answers that might be obtained. One may quite reasonably ask this question "How would the uniform animal group react if by some means the efficiency of the liver had been reduced by 25 per cent?"

The very uniformity of response of a uniform group under no stress but that of the experimental substance makes it difficult to interpret the findings in terms of man and, after all, such interpretation is the ultimate purpose of a large part of animal experimentation. Man as a group is probably as heterogeneous as we can find in nature. It would indeed be difficult to find a group of so-called normal human beings that did not represent a multitude of perhaps "dormant" stress conditions.

It would seem desirable, therefore, to supplement the test as outlined on "normal" groups with tests on "stress" groups.

It should not be implied that a deliberately heterogeneous group of animals should be selected for study. Such a procedure would be self-defeating, since the number of variables would make it difficult to gain a statistically valid result. It would be desirable, however, to produce animal groups from uniform stock in which a stress situation had been developed. For example, it should be possible by giving a hepatotoxin such as carbon tetrachloride to maintain a "sick" liver. Experiments on a few toxic responses of animals to insecticide during a short period in which they received from 0.5 to 1.0 ml./kg of carbon tetrachloride have been carried out successfully.

Possibly for other stress situations should be mentioned: nephrotoxins (uranium or mercury salts); disturbances of thyroid function (thiouracil); disturbances of pancreatic function (alloxan); experimental anemias, and finally, as a special category, cancer-sensitive animals. This latter type of stress group has been highly developed for uniformity of response.

Uniformity of response in a particular stress group is the most desirable, but it cannot be stated whether it would be possible to maintain all such proposed stress groups and keep them reasonably uniform over a normal lifetime. However, experiments even if limited in time by increased morbidity of groups would be extremely valuable. Thus, by interacting a number of well-defined functional inadequacies with the particular test

substance, it becomes possible to define with somewhat greater assurance what the response of heterogeneous man might be . . . the well man, the sick man, the man whose liver is slightly abnormal but for whom no present clinical hepatofunctional test is definitive and for whom final diagnosis becomes uncertain.

Obviously, the number of animal groups that could be suggested would rapidly outrun most laboratory facilities. A certain amount of judgment strengthened by collateral tests for practical and theoretical considerations would usually decide what a reasonably good estimate of safety would be. If, for example, routine tests with "normal" groups give a positive answer, there would probably be little reason for compounding a test with a stress group. On the other hand, a negative response on a test substance in a "normal" group should not always lull the experimenter into a false sense of security, particularly when that test substance might have very wide contacts with man.

**Direct Additives.**—In discussing the subject of chemical additives, it has become the practice to distinguish between those chemicals which are added directly to the product in connection with its manufacture or preparation generally and the other class of chemicals which get into the food indirectly by environmental contact such as containers, for example, or a pesticide residue. This breakdown presents no real consumer interest which is the same regardless of how the chemical gained entrance to the product.

There is some convenience in presenting this subject of chemical additives to use the direct-indirect breakdown. Accordingly, the following list of additives includes only those that are added directly to the product. The list also gives the reason for using the additive. These chemicals are permitted by the Federal Meat Inspection Service to be used in the manufacture of meat products prepared in inspected establishments.

| *Additive* | *Purpose* | *Product* |
|---|---|---|
| 1. Anti-foam A (methyl polysilioxane) | Prevent foaming | Soup |
| 2. Ascorbate, sodium | Accelerate color fixing, inhibit fading. | Cured cuts; cured, comminuted product. |
| 3. Ascorbic acid | Accelerate color fixing, inhibit fading. | Cured cuts; cured, comminuted product. |
| 4. Bacterial starters and lactic acid starter culture. | Flavor developer. | Dry sausage, pork roll. |
| 5. Benzoate, sodium | Retard flavor reversion. | Oleomargarine |
| 6 Benzoic acid | Retard flavor reversion | Oleomargarine |
| 7. BHA (butylated hydroxyanisole | Inhibit rancidity development | Lard and shortening. |
| 8 BHA | Inhibit rancidity development. | Unsmoked dry sausage. |
| 9 BHT (butylated hydroxytoluene) | Inhibit rancidity development. | Lard and shortening. |
| 10 Carbonate, sodium | Treatment of tripe. | Tripe |
| 11 Caseinate, sodium | Binder | Imitation, nonspecific loaves. |

| *Additive* | *Purpose* | *Product* |
|---|---|---|
| 12. Caustic soda | Treatment of tripe. | Tripe |
| 13. Citrate, sodium | Prevent coagulation. | Beef blood |
| 14. Citric acid | Prevent coagulation. | Beef blood. |
| 15. Citric acid | Increase effectiveness of antioxidants. | Lard and shortening. |
| 16. Citric acid | Increase effectiveness of antioxidants. | Unsmoked dry sausage. |
| 17. Citric acid | Flavoring | Chili con carne |
| 18. Coal tar dyes | Coloring sausage casings and some fats. | Oleomargarine |
| 19. Diacetyl | Flavoring | Oleomargarine |
| 20. Hydrogen peroxide | Bleach | Tripe |
| 21. Hydrolyzed plant protein | Flavoring | Various |
| 22. Isoascorbate sodium | Accelerate color fixing inhibit fading. | Cured cuts, cured comminuted product. |
| 23. Isoascorbic acid | Accelerate color fixing inhibit fading. | Cured cuts, cured comminuted product. |
| 24. Isopropyl citrate. | Prevent flavor reversion. | Oleomargarine |
| 25. Lecithin | Inhibit rancidity development. | Lard and shortening. |
| 26. Lecithin | Emulsifier | Oleomargarine and shortening. |
| 27. Lime | Denuding | Tripe |
| 28. Mono-and di-glycerides | Emulsifier | Lard, shortening and oleomargarine. |
| 29. Monoisopropyl citrate. | Increase effectiveness of antioxidants | Lard and shortening. |
| 30. Monosodium glutamate | Flavoring | Various |
| 31. Natural coloring matters. | Coloring sausage casings and some fats. | Oleomargarine |
| 32. NDGA (nordi-hydroguai-*aretic acid)* | Inhibit rancidity development | Lard and shortening. |
| 33. Nitrate, potassium | Color fixing. | Cured products. |
| 34. Nitrate, sodium | Color fixing. | Cured products. |
| 35. Nitrite, potassium | Color fixing. | Cured products. |
| 36. Nitrite, sodium | Color fixing. | Cured products. |
| 37. Papain | Improving palatability. | Frozen cuts. |
| 38. Phosphate, disodium | Decrease amount of cooked out juices. | Ham, pork shoulder picnics and the like. Canned chopped ham. |
| 39. Phosphate, sodium acid pyro- | Decrease amount of cooked out juices. | Ham, pork shoulder picnic and the like. Canned chopped ham. |
| 40. Phosphate, sodium hexameta- | Decrease amount of cooked out juices. | Ham, pork shoulder picnic and the like. Canned chopped ham. |
| 41. Phosphate, sodium pyro- | Decrease amount of cooked out juices. | Ham, pork shoulder picnic and the like. Canned chopped ham. |
| 42. Phosphate, sodium tripoly- | Decrease amount of cooked out juices. | Ham, pork shoulder picnic and the like. Canned chopped ham. |
| 43. Phosphoric acid | Increase effectiveness of antioxidants. | Lard and shortening. |
| 44. Propyl gallate | Inhibit rancidity development. | Lard and shortening. |
| 45. Resin guaiac | Inhibit rancidity development. | Lard and shortening. |
| 46. Sodium metasilicate | Denuding | Tripe |

| Additive | Purpose | Product |
|---|---|---|
| 47. Sodium sulfoacetate derivatives of mono- and di-glycerides | Emulsifier | Oleomargarine |
| 48. Stearyl citrate | Prevent flavor reversion. | Oleomargarine |
| 49. Tannic acid | Clarifying. | Rendered fats. |
| 50. Trisodium phosphate | Denuder | Tripe |
| 51. Tocopherol | Inhibit rancidity development. | Lard and shortening. |

**Indirect Additives.**—Three groups of additives are included under this heading. The first is identified with packaging materials, the second is concerned with pesticide residues, and the third includes those additives that result from administering such things as hormones, antibiotics, and tranquilizers to the live animal.

**Packaging Materials.**—The development of a tremendous range of plastic materials has profoundly influenced the packaging of food products and particularly meats. These plastics have been used as such, they have been used to treat many kinds of conventional packaging materials, and their method of application has presented new problems by contrast with use of traditional packaging devices.

Because of the intimate relationship between the food and its container, *the packaging material must contain no element that will impart unwholesomeness to the food.* Many packaging materials have been reviewed and investigated to make sure that only those which are safe are used in packaging food products. Following is a list of chemicals that have been approved for use in packaging materials applied to meat products under the Federal meat inspection program.

| | |
|---|---|
| Synthetic Resins | Polyvinyl chloride<br>Polyvinyl acetate<br>Polyvinyl chloride-acetate<br>Vinylidene chloride<br>Polystyrene<br>Polyethylene<br>Cellulose acetate<br>Regenerated cellulose<br>Terephthalic acid-ethylene glycol copolymer<br>Butadiene-acrylonitrile (perbunan or hycar synthetic rubber)<br>Epon 1001, 1007, 1009<br>Polyvinyl butyral |
| Plasticizers | Ethyl Phthalyl ethyl glycolate (E-15)<br>p-tertiary Butyl phenyl salicylate<br>3-(2-Xenoxy) 1, -2-epoxypropane<br>2-Ethylhexyl diphenyl phosphate (Santicizer 141)<br>Butyl phthalyl butyl glycolate (B-16)<br>Glycerol Monooleate<br>Acetyl tributyl citrate (Citroflex A-4)<br>Di-iso-butyl adipate<br>Butyl stearate<br>Glycerol<br>Dibutyl Sebacate<br>Sorbitol<br>Acetyl triethyl citrate (Citroflex A-2) |

| | |
|---|---|
| Combination Plasticizer-stabilizers | Paraplex G-60<br>Paraplex G-62 |
| Stabilizers | Aluminum monostearate<br>Calcium acetate<br>Calcium ethyl acetoacetate acetate<br>Calcium carbonate<br>Calcium stearate<br>Calcium glycerophosphate<br>Mono-, Di-, and tricalcium phosphate<br>Calcium oleate<br>Calcium ricinoleate<br>Magnesium stearate<br>Magnesium glycerophosphate<br>Mono-, do-, and trimagnesium phosphate<br>Disodium hydrogen phosphate<br>Ammonium potassium phosphate<br>Tin oxide<br>Tin stearate<br>Tin oleate<br>Tin palmitate |
| Lubricants | Metallic soaps such as the oleates, stearates, and palmitates of aluminum, calcium magnesium and zinc. Carnauba wax, paraffin and Acrawax C. |
| Pigments | Lakes of food dyes<br>Iron oxide<br>Titanium dioxide<br>Ultramarine Blue<br>Prussian Blue<br>Copper phthalacyanine Blue<br>Tungstated organic blues<br>Carbon black<br>Chrome oxide green (chromic oxide, hydrated—not "chrome green") |

**Pesticide Residues.**—The widespread use of synthetic organic pesticides since 1940 has emphasized several problems previously not significant in the field of practical insect control. These problems are concerned with all aspects of the very real difficulty encountered in attempts to establish quantitatively the magnitudes and locales of persisting residues of these organic pesticidal substances, especially as they occur in man's food supply.

The food control officials' concern with the possible presence in foods of deleterious amounts of persisting pesticides undoubtedly relates to the well established phenomena that (1) being oil and wax soluble, most of the new pesticides cannot be expected to persist for any time as extrasurface deposits on plant parts or on animals, (2) when ingested in sublethal amounts by a warm-blooded animal, many of them are deposited in part in the fat depots serving the liver from which they presumably can be mobilized in lethal amounts during periods of physiological stress, and (3) penetrating pesticides are not amenable to easy removal from plant or animal tissue and therefore we may expect repeated exposures to such residues in our food supply.

Although most pesticides are subject to weathering and other losses under field conditions, many of the synthetic organic pesticides persist on or in the commodity in decreasing amounts for remarkably long periods of time. Actually, these persisting residues of pesticidal materials challenge

the ingenuity of the residue analyst. The food control official is required to reconcile the foregoing with the position of importance that the use of pesticides has attained in the agricultural economy and the consumer interest in an abundant and high-quality food supply. The necessity for the use of pesticides such as insecticides, weed killers, and fungicides in the production of an adequate, wholesome and economical food supply is well established. Dr. H. L. Haller, when he was Assistant Director of the Crops Research Division, Agricultural Research Service, United States Department of Agriculture, stated "Over one-half of the commonly used foods grown in the United States require the use of pesticides." Dr. Fred C. Bishopp, before his retirement as Assistant Chief of the Bureau of Entomology and Plant Quarantine of the United States Department of Agriculture, emphasized this fact in these words: "An abundance of high-quality food and fiber crops is absolutely dependent upon the use of a diversified group of pesticides . . . without pesticides, vegetables, fruits and cereals would be unmarketable even by low standards. Wormy apples and cabbage, weevily cereals and other infested foodstuffs with the accompanying wastes of insects would reach the market in a condition unfit for human food."

An amendment to the Federal Food and Drug Law called the "Pesticide Amendment" enacted July 22, 1954, contains legislative provisions aimed at the protection of the consumer in connection with the occurrence of pesticide residues in food. This amendment was also called the Miller amendment in honor of Congressman A. L. Miller of Nebraska who, as Chairman of the House Committee on Interior and Insular Affairs, was a member of the select committee to investigate the use of chemical additives in foods, drugs, and cosmetics. The bill which he introduced and which later came to be known as the Pesticide Amendment to the Food and Drug Law was an outgrowth of the information obtained by the select committee while holding hearings and in many hours of conferences with industry, college, and farm groups, and governmental agencies.

The Pesticide Amendment changes and improves existing laws in the following respect:

(1) A *specific* method for controlling the residue of pesticide chemicals which may remain in or on raw agricultural commodities is set up which is distinct from that controlling other poisonous or deleterious substances which are used in or remain on processed, fabricated, and manufactured food. In this way recognition is given to the peculiar economic, agricultural and public health problems which are important in the regulation of pesticide chemicals. Unlike many other chemicals, pesticide chemicals are necessary instruments of agriculture in producing and expanding our food supply and are comprehensively regulated by the Department of Agriculture under the Federal Insecticide, Fungicide and Rodenticide Act.

(2) The determination of questions of agricultural usefulness and probable residue levels involved in the establishment of tolerances is made a function of the Department of Agriculture, while the determination of questions of a public health nature remains a function of the Department of Health, Education and Welfare. In this way, a more logical grouping of governmental functions is effected than under existing law which casts

responsibility for determining agricultural questions as well as public health questions upon the Department of Health, Education and Welfare.

(3) Before any pesticide-chemical residue may remain in or on a raw agricultural commodity, scientific data must be presented to show that the pesticide-chemical residue is safe from the standpoint of the food consumer. The burden is on the person proposing the tolerance or exemption to establish the safety of such pesticide-chemical residue.

(4) Specific time limits for informal administrative action in establishing tolerances are prescribed to avoid the adverse consequences of inaction and protracted delay. Promptness is vital in this area of regulation to all concerned.

(5) Provision is made for the appointment of independent committees of scientific experts selected by the National Academy of Sciences to study proposed regulations establishing tolerances for pesticide chemicals and to make recommendations thereon to the Department of Health, Education and Welfare.

(6) The procedure prescribed for establishing tolerances emphasizes informal proceedings rather than the formal public hearing type of proceeding. This is accomplished in two ways: First, the bill sets up a procedure whereby the manufacturer or formulator most directly concerned with the establishment of a tolerance for a particular pesticide chemical has the right to initiate the proceedings for a tolerance on that chemical by filing a petition; second, the bill provides for the initial setting of tolerances without a formal public hearing, limiting such hearings to issues which may remain in dispute at the conclusion of the informal proceedings. Existing law requires a formal public hearing before any tolerance can be established and such a proceeding can be initiated only upon the request of a substantial segment of the industry or upon the initiation of the government.

(7) Where the informal procedures do not produce a satisfactory tolerance or exemption, the rights of all concerned to a full and fair hearing on the disputed issues are preserved.

(8) Provision is made for the exemption of pesticide chemicals from the requirements of a tolerance, in cases where tolerances are not necessary to protect the public health and for the establishment of temporary tolerances for those pesticide chemicals which are used in or on raw agricultural commodities under experimental permits issued by the Department of Agriculture.

Insecticides commonly used at the present time belong to one of two principal groups, the chlorinated hydrocarbons or the organic phosphates. A few of the organic phosphates have chlorine atoms incorporated in the molecule. The commonly used chlorinated hydrocarbons are DDT, lindane (or BHC), toxaphene, chlordane, DDE, methoxychlor, TDE, aldrin, dieldrin and endrin. The latter three compounds are not, strictly speaking, chlorinated hydrocarbons but are grouped with them because their toxic activity is similar. The commonly used organic phosphates are parathion, TEPP, malathion, EPN, and diazinon. DDVP is an example of a chlorine containing organic phosphate. Its use is limited because of high mammalian toxicity. There are a small number of insecticides of minor importance in

addition and, of course, new insecticides are being continually developed. In addition to the insecticides there is a long list of fungicides, miticides, nematocides, and herbicides of varying degrees of importance in relation to animals.

An animal may be exposed to these compounds either by direct contact, such as spraying, dipping, or rubbing or by consuming forage which has been treated. The use of systemic insecticides such as the cattle grub treatment is becoming more common. Insecticides may be applied to cattle by sprays, dipping vats, or by suspended appliances on which the cattle rub their backs to rid themselves of flies. Spray-dipping machines and self-sprayers are coming into more common use. Sheep are usually treated by dipping or dusting. Most pigs are now sprayed with insecticides and miticides. Treated wallows are also used. The insecticides most used for direct application are lindane (or BHC), chlordane, and toxaphene except for spraying dairy cattle in which case malathion is probably the most used insecticide. Forage which animals consume may contain any of the pesticides in amounts depending upon the time of treatment and the volume of spray or dust applied to the crop. Certain insecticides, notably BHC, may pass from the soil into growing crops. BHC used on cotton is known to have been present in potatoes grown on the same land the following year in sufficient quantity to make the potatoes unpalatable. Miticides are in general some of the same chemicals used as insecticides and the animal exposure would be from direct application. Fungicides may be used on grain and forage consumed by an animal. Nematocides are usually applied to the soil and animal exposure would be limited to uptake by plants growing on the soil and eaten by animals. Herbicides, such as 2,4,D, used to kill weeds in pastures are likewise a residue hazard.

Chlorinated hydrocarbon insecticides accumulate in the fat of exposed animals. Some of the organic phosphates also appear in the fat, some appear to partition between fat and lean, and others are completely absent from the fat. The fate of many of the pesticides in the animal body has not been more than superficially determined.

Two types of methods are available for the determination of insecticide residues, those by the use of which the amount of a specific chemical can be determined, and those which will indicate the presence of a group of chemicals. Biological assay will indicate the presence of a toxic substance from any source

The only reliable specific methods available at the present time enable the chemist to determine the presence and amount of DDT, methoxychlor, and benzene hexachloride. A few other specific methods have been proposed, particularly infra-red determination of the aldrin type chemicals, but these have been found to be either lacking in sensitivity, unadaptable to routine use, or subject to interferences not eliminated in sample clean up. General methods include organic chloride determination, cholinesterase inhibition, and biological assay. Organic chloride methods involve either saponification of fat and concentration of the insecticide fraction with subsequent determination of inorganic chloride, or combustion of the sample and chloride analysis of absorbed products of combustion. Cholinesterase inhibition is characteristic of all organic phosphate insecticides. The pho-

phate residue can be separated by chromatography and determined by treatment of the enzyme. Residues for this work have been obtained only from the surface of certain crops. Methods have not been worked out for separating organic phosphate residues from meat.

Biological assay is usually carried out by the use of flies. The toxic material is separated from the sample and a standard weight of flies exposed to the residue under carefully controlled conditions for a fixed lapse of time. At the end of this period the lethal dose is determined by counting the number of dead and living flies. Mosquitoes and other insects have also been used. In dealing with mixtures of insecticides or with samples of unknown history, general methods are little more than qualitative. A general method is valuable in sorting out samples which are free of residues. In case residues are found, samples can be tested for DDT, methoxychlor and BHC and the amount present, if any, determined. No other insecticides can be determined with certainty in a sample of unknown history.

All of the general methods have obvious limitations. The organic chloride concentration and extraction method will not show the presence of the aldrindieldrin type of insecticide. This method as well as the combustion method will not distinguish toxic from inocuous organic chlorides. Nontoxic weathered residues eaten with forage by an animal, or nontoxic insecticide metabolites would appear the same as toxic residues. However, if organic chlorides are found and subsequent DDT, methoxychlor, or BHD determinations account for all the chloride, it is apparent that no other organic chlorides are present.

The fly assay is limited by the variable sensitivity to specific chemicals of the test organism compared to other organisms. For example, about 80 micrograms of toxaphene are required to kill flies in the assay, whereas 1 or 2 micrograms will kill mosquitoes. These differences in susceptibility extend to other animals including man. Differences in tolerance levels which may be set for various insecticides will also limit the usfulness of the fly assay. A sample extract which would kill flies under standard assay conditions could be within the tolerance if the insecticide present were methoxychlor. Sample dilutions could resolve this difficulty. However, if a tolerance for BHC, for example were set a 1 ppm compared to 3 ppm for methoxychlor a diluted sample could indicate no toxic residue in a sample which in fact was far above the tolerance for BHC.

**Chlorinated Hydrocarbons.**—DDT was first synthesized by Zeidler in 1874. The original discovery of the insecticidal activity of DDT was made in the Basle Laboratories of J. R. Geigy, S. A. in 1939 in the course of a search for a moth-proofing compound. It was extensively tested in Switzerland in 1940-41 when the insecticide proved exceptionally effective by checking the plague of Colorado beetle that threatened the Swiss potato crop.

The chemical was introduced into England and the United States in 1942. Production was started in those countries by the Geigy Company in 1943.

Benzene hexachloride insecticidal activity was discovered simultaneously in France and England in 1942-1943.

Toxaphene was developed as a result of an observation that chlorinated turpentine has insecticidal properties.

When DDT was developed in the course of a search for a moth-proofing compound, its contact insecticidal properties were recognized. It was at this stage that the work was extended to investigate as contact insecticides the numerous synthetic chemicals being produced in connection with the

INSECTICIDE "FAMILIES"

*Grouped According to Chemistry and Responses of Resistant Insects*

| *INSECTICIDE* | *GROUP* | *FAMILY* |
|---|---|---|
| DDT<br>Methoxychlor<br>Perthane<br>TDE | DDT | Chlorinated Hydrocarbons |
| Aldrin<br>Chlordane<br>Dieldrin<br>Heptachlor<br>Strobane<br>Toxaphene | Chlordane | |
| BHC<br>Lindane | Lindane | |
| Dilan | Dilan | |
| Chlorthion<br>DDVP<br>Diazinon<br>Dipterex<br>EPN<br>Malathion<br>Parathion<br>TEPP<br>4124 (American Cyanamid) | (Group relationships not yet apparent) | Organic Phosphates |
| Lethanes<br>Thanite | | Organic Thiocyanates |
| Arsenicals<br>Borax<br>Sodium Fluoride | | Inorganic Insecticides |
| Pyrethrins, Allethrin<br>Rotenone<br>Ryania | | Botanicals |

FIG. 123.

moth-proofing experiment. It was recognized that in developing a contact insecticide, the problem was the same, namely, to concentrate the poison at the point where it would be most effective. However, the mechanism had to be quite different and the molecular structure had to be correspondingly different.

The majority of contact insecticides enter the body of the insect through the cuticle, either through the thin walls at the base of the numerous pores through which the hairs emerge and which are distributed unevenly all over

the body, or through the thin inter-segmental membranes. Thus they enter the nerve substance and the evidence is that they act largely on the nervous system. Investigators postulated the working hypothesis that the fundamental essential in a contact insecticide is that it shall be lipoid soluble. This lipoid soluble contact component is brought in intimate contact with the chitin cuticle, thus enabling it to penetrate over the lipoids and lipo-proteins of the chitin cuticle into the nerve endings. This enables the insecticide to concentrate at the point or points where it will exercise its greatest effect.

A very small quantity of poison accumulating in the lipoids of the nerve substance is sufficient to initiate poisoning. However, the component providing lipoid solubility must be present if the toxic component is to penetrate by contact into the body of the insect.

The action of DDT on flies has been described as follows: Flies coming into contact with DDT first have a period of great excitement. Then, a progressive paralysis sets in, first affecting one pair of legs then the others. The flies at this stage have difficulty in walking straight though they may still fly. They then make walking movements without making progress. Finally, they turn on their backs, the legs waving freely in the air, and so die.

This coincides with the postulated action of these contact insecticides. It has been computed that one billionth of a gram per square centimeter is sufficient to kill a fly or a moth catapillar in a few hours.

**Organic Phosphate Insecticides.**—Investigations carried on in Germany during World War II for new chemical warfare agents led to the development of the organic phosphate insecticides. When toxicity studies were made on a number of these compounds, they were found to be lethal to insects in very low concentrations. Development was then undertaken to make a good insecticide with low volatility, high stability, and safety in manufacture and application.

From this work emerged several compounds of which parathion and TEPP (tetraethylpyrophosphate) were the first to be used on a large scale. Since then, other organic phosphates have been developed and they are unusually effective over a wide range of insects species, coupled with the fact that insects do not develop resistance to them to any significant degree. However, most of them are too acutely toxic to be handled by amateurs and their use was restricted to specialists in pesticide application. More recently, malathion has been introduced and this product combines a high degree of insecticidal efficiency with a remarkably low order of mammalian toxicity. Other equally satisfactory organic phosphates have been developed and are commercially important.

Although the organic phosphates have been identified in the popular mind with "nerve gasses", the pesticides are not gasses but oily liquids. Their volatility is so low that at ordinary temperatures there is not sufficient vapor present in equilibrium with the liquid to constitute a hazard. They decompose chemically with varying degrees of rapidity by weathering under conditions of use, so that their residues have little persistence. The most characteristic property of the phosphate insecticides as a class apart from the presence of the phosphorous atom in their chemical structure is their capacity to inhibit the action of the enzyme cholinesterase.

Cholinesterase is an essential element in nervous control.

Nervous control is exerted by impulses which originate centrally and travel along the nerve to the effector organ. All effector organs contain "receptor sites" which are the terminal points in the chain of transmission. We are concerned here with the process whereby the impulse bridges the gap between the endings of the nerve fiber and the receptor sites in the organ. This is accomplished by the liberation of a small quantity of the chemical compound known as acetylcholine. This compound is present in all so-called cholinergic nerve fibers.

In the resting state of the nerve, the acetylcholine must exist in some bound form, but when the fiber is stimulated, it appears at the nerve ending in an active and diffusible state. From the nerve ending it is carried by the tissue fluid to the receptor site where it produces the response characteristic of the particular effector organ, *e.g.*, contraction of a muscle or secretion by a gland.

The body must have a mechanism for disposal of a substance physiologically as potent as acetylcholine, otherwise a single stimulus would induce a persistent state of cholinergic activity. This disposal is effected by the enzyme cholinesterase which splits acetylcholine to choline and acetic acid.

The basis of most methods of assay for an organic phosphate insecticide is the so-called cholinesterase test. In measuring the activity of the enzyme, the production of acetic acid forms the basis for the test.

**Estrogen Residues.**—Compounds with estrogenic activity have been fed to cattle and poultry to improve growth and feed efficiency. It is estimated that about two-thirds of all cattle in feedlots in the United States are being treated with estrogenic compounds. Also, many millions of chickens and turkeys are being so treated annually. Diethylstilbestrol is available by chemical synthesis and is most commonly used for this purpose.

The natural hormones, estradiol and progesterone, are also used.

The diethylstilbestrol is available in two forms for the cattle industry. It is used in the feed and also in the form of pellets. The pellets are implanted in the ear. The pellets have also been used in the poultry industry for several years. Another synthetic compound, dinestrol diacetate, closely related to diethylstilbestrol, is available for oral use in poultry.

Since these compounds are not destroyed by cooking and in any case meat is frequently eaten without adequate cooking, it is important to know how much of these hormones might be present in the meat at the time of consumption. Thorough investigation reveals that meat produced from animals and birds treated with the hormones contains a negligible amount of estrogenic activity. Much larger amounts of estrogens are synthesized by men and women daily, circulated in the blood stream and metabolized or excreted in the bile or urine. Animals and humans consume foods containing compounds with estrogenic activity under normal conditions. These include milk, lettuce, alfalfa, clover, wheat, oats, and corn.

The implanted pellets of estrogenic material present a different problem, however. Controls must be exercised to assure that these pellets are implanted in such a way and at such a location that they will be effectively separated from the edible portion of the carcass as the animal or bird is being processed for human food.

**Antibiotic Residues.**—Antibiotics are widely used in the treatment of food animals and poultry. As therapeutic agents they are being used both for treatment and prevention of disease.

Investigation indicates that antibiotics are metabolized rapidly by the body. The residue hazard is regarded as being negligible as animals are normally brought to the packing plant. Occasionally, it becomes necessary to use antibiotics in the treatment of animals that become diseased after arriving in the pens of the packing plant. When such animals are treated with antibiotics they are held for at least forty-eight hours before slaughter, after treatment.

Chapter

# 16

## IONIZING RADIATION

**The Atom.**—Physicists are satisfied that atoms have a definitely organized internal structure. They have succeeded in exploring the interior of these tiny units. All of them include two main parts: a nucleus and an electron cloud. Because of their physical and chemical behavior, it is believed that the nucleus is centrally located and is enveloped by the electron cloud which is composed of an orderly moving group of orbital particles. So definite is this conception that it has become customary to think of atoms as miniature solar systems. Energy changes inside atoms produce ionizing radiations.

Atomic nuclei are made up of various combinations of two types of fundamental particles called protons and neutrons. The orbital particles composing the electron cloud are called electrons. Hydrogen is an exception having only one proton and no neutron.

Powerful forces tug at the protons and neutrons in the nuclei of atoms. Some of the forces act to keep the nuclear particles together. This group includes the strong, attractive nuclear forces, existing between neutron particles. Other of the forces tend to thrust the nuclear components apart. This group includes the electrostatic or coulomb forces between the protons tending to push them away from each other. In some of the combinations the balance is steady and hard to upset. Nuclei of this sort endure and are spoken of as being stable. In other of the combinations the balance of forces is much more easily upset. Nuclei of this sort will undergo spontaneous rearrangement, ejecting charged particles to attain more stable combinations of protons and neutrons. These isotopes are unstable; their nuclei are said to undergo radioactive decay; and they are called radioactive isotopes or radioisotopes.

All radioisotopes whether natural or artificial decay by emission of alpha, beta, gamma radiations or combinations of these. Alpha radiations are high-energy, charged particles consisting of two protons and two neutrons. Alpha rays are streams of alpha particles.

Beta radiations are energetic particles having a mass and electric charge equal in magnitude to those of an electron. The charge may be either positive or negative.

Gamma radiations are high-energy photons, or rays similar to light or radiowaves but of much higher frequency. They have no electric charge.

The naturally occurring radioisotopes are frequently alpha emitters while the artificial or man-made radioactive substances are almost all beta emitters. Any particular radioactive atom is either an alpha emitter or a beta emitter. It cannot emit both kinds of particles simultaneously. However, a single atom can emit both an alpha and a gamma radiation or a beta and a gamma radiation.

**Ionizing radiation.**—Alpha particles have large specific ionization values. Since they create many ions per unit of path lengths, they dissipate this energy rapidly and penetrate only short distances. Alpha particles are normally a hazard to health only in the form of internal radiation.

Gamma rays and *x*-rays have quite low specific ionization values. They ionize sparsely over long paths and are quite penetrative. As a group, these radiations constitute the chief health hazard of external radiation, although gamma-rays can be a hazard also as internal radiation.

Beta particles are light in weight and carry single negative or positive charges. Their specific ionization values are intermediate between those of alpha particles and gamma and *x*-rays. They ionize matter somewhat sparsely, dissipating their energies relatively quickly, and are moderately penetrative. Beta particles can be a health hazard either as internal or external radiation.

Ionizing radiations whether they arise from radioactive decay, from radiation-producing machines, or from cosmic sources, share one distinctive property. Whatever their source during the process of absorption all types interact with matter by splitting atoms and molecules. Ionization can occur in any kind of matter. Ionization of living matter results in tissue changes that may affect health. The degree of tissue ionization produced depends upon the composition of the tissue and the quantity, type, and energy of the radiation.

Most particulate radiations, such as alpha and beta radiations, are completely absorbed or stopped by relatively thin layers of matter.

In contrast, gamma- and *x*-rays are only attenuated by passing through matter. Successive layers of identical material and thickness reduce these radiations by the same ratio.

The remarkable effectiveness of ionizing radiations in causing biologic injury stems from their property of acting directly on the individual atoms and molecules composing tissue. Radiations may eject electrons from atoms, break up chemical compounds, displace atoms in organized molecules and, in general, cause quite important changes in the submicroscopic structure of cells.

Knowledge of how ionizing radiations cause injury to tissue is incomplete. Regardless of how the biologic changes are produced, agreement is general that exposure to atomic radiations is basically harmful to body tissues. The theories differ in specific detail, but most of them are based on a standard idea: that tissue damage probably stems from ionization of atoms in or near living cells with a consequent rupture of the molecules containing these ionized atoms.

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**Roentgen.**—By definition the roentgen measures absorption of gamma and $x$-ray only. It was named in honor of Wilhelm Roentgen who made the first practical use of $x$-rays more than fifty years ago.

The roentgen unit is applied to both gamma radiations and X- radiations because, except for the sites of their origin in the atom, these two radiations are basically identical. X-rays are most familiar as the radiation produced by medical and industrial $x$-ray machines; gamma rays as one of the radiations from radioactive substances.

Although the roentgen actually is an expression of the ability of gamma radiations and $x$-radiations to ionize air, it has come to be used also as a measure of radiation dosage.

Because the roentgen applies only to gamma rays and $x$-rays, there is need for an additional unit to express dosage of the other kinds of ionizing radiation. The roentgen equivalent physical (rep) is used for this purpose. For practical purposes it may be said that 1 roentgen equivalet physical is the amount of beta, alpha or other particulate ionizing radiation whose absorption imparts to tissue the same amount of energy as does the absorption of the roentgen of gamma or $x$-radiation. Roentgens equivalent physical are computed rather than measured.

**Curie.**—For measuring amounts of a radioactive substance, it bas become customary to use the rate of its radioactive disintegration rather than the effects of the radiation it produces or the radiation itself. This is necessary because some radioactive substances emit more than a single radiation with each disintegration.

The curie is the effective unit of radioactive disintegration. It was named in honor of the Curies for their pioneer work with uranium, radium, and polonium. One curie, biologically speaking, is a very large amount of radioactivity. For practical purposes, a gram of pure radium is 1 curie of radium. Two smaller units or sub-units, the millicurie, 1/1000th curie (mc) and the microcurie, 1/1,000,000th curie (uc) are frequently used to measure biologically significant amounts of radioactive substances. One-tenth of a microcurie (0.1 uc) of radium fixed in a human body is considered to be the maximum amount that within a lifetime will produce no noticeable effects. The threshhold amount of radium fixed in the tissues for production of the most serious effects, anemia and damage to bone, appears to be of the order of 1 microcurie (1 uc).

Even very low levels of radiation can have serious biological effects on humans. The inheritance mechanism is by far the most sensitive to radiation of any biological system. Any radiation which reaches the reproductive cells causes mutations that are passed on to succeeding generations. These changes occur in the material governing heredity. Human gene mutations which produce observable effects are believed to be universally harmful.

There is no minimum amount of radiation which must be exceeded before mutations occur. Any amount, however small, that reaches the productive cells can cause a correspondingly small number of mutations. The more radiation, the more mutations. It is difficult to arrive at a figure showing how much genetic harm radiation can do. One measure is the amount of

radiation above the natural background which would produce as many mutations again as occur spontaneously. It is estimated that this amount is 30 to 80 roentgens.

The population of the United States is exposed to radiation from (*a*) the natural background (*b*) medical and dental *x*-rays (*c*) fall-out from atomic weapon testing. Very little is now known about how to treat pathological effects of radiation or how to protect the body against them in the first place. One of the effects is a shortening of life. This seems to involve some generalized action. Irradiated individuals may age faster than normally even if they do not develop specific radiation-induced diseases like leukemia.

**The Nature of Radiation.**—Broadly speaking, radiation is a way in which energy moves from one place to another. Thus, the energy released when a stone is dropped into water radiates away in circular waves. Sound energy radiates from a speaker's mouth to a listener's ear; light and heat energy radiate from the sun to the earth. Electrons, radiating from a hot wire, provide the energy that forms the picture in a television set. In the first four examples the radiation consists of waves, that is, water waves, sound waves, light waves, heat waves. In the last, the radiation is a stream of minute particles.

Atomic radiation also transports energy, carrying it away from over energetic atoms. X-rays, the most familiar example, are waves like light waves only very much shorter. To give some idea of the scale, a water wave or a sound wave may be inches or feet long; a light wave is about a hundred-thousandth of an inch long; a medium-short *x*-ray about a billionth of an inch. Another group of atomic radiations called gamma rays are like *x*-rays but are usually still shorter. Their wave length goes down to about a ten-billionth of an inch.

One of the major discoveries of modern physics is that the shorter the wave length of any wave radiation, the more energy each unit of it carries. Hence, *x*-rays and gamma rays are enormously more energetic than light. They penetrate much farther into all kinds of matter and they produce much larger effects.

In addition to waves, atoms are now known to radiate a great variety of particles. These are all infinitely tiny (measuring in 100-trillionth of an inch), unimaginably light and known to us only indirectly through their effects. Some of the more important particles are: Electrons. The lightest particles carrying a negative electric charge. Radiation electrons are sometimes called "beta rays". Protons. About two thousand times as heavy as electrons and positively charged. Neutrons. Like protons but uncharged. Alpha particles. Each one is an assembly of two protons and two neutrons.

Atomic radiation is given off by atoms which have more than the normal complement of energy—"Excited" atoms is the physicist's phrase. How does the atom get excited? One way is to be struck by a projectile. There is nothing very mysterious about this. If a bullet strikes a metal target, energy is added to the target—it is excited. This energy is then radiated

away in the form of waves which carry off the noise and heat of impact. There may also be particle radiation if the bullet knocks some pieces out of the target. In the same way, a bullet of atomic dimensions excites an atom that it strikes. The excess energy is radiated away in the form of waves (x-rays, gamma rays), particles (fragments from the target atoms), or both.

In an x-ray machine, a stream of fast-moving electrons is made to strike a metal target. This excites some of the electrons in the atoms of the target. In the process of giving off the excess energy thus gained, the atomic electrons send out x-rays.

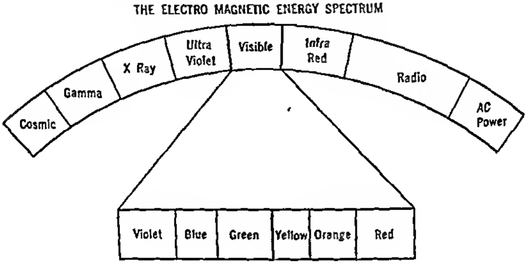



Fig. 124

Not all radiation comes from atomic collisions, however. Some atoms are naturally excited and emit radiation spontaneously. These are atoms of radioactive substances such as radium. The nuclei of radioactive atoms erupt from time to time giving off alpha particles, electrons, or gamma rays.

Two important sources of radiation are naturally radioactive atoms and atoms made artificially radioactive by bombardment.

When radiating waves or particles pass through any substance at least some of them bump into molecules. The effect may be no more than knocking a few electrons out of the molecules or it may be more drastic. But even if just a few electrons are knocked loose, the molecules become very active chemically and form new combinations. Now a living cell is a marvelously delicate balance of interactive materials. Each molecule must be just what it is to play its proper role. Hence, any chemical change in a cell, however slight, may have serious effects. It may substantially change the normal life process or even kill the cell.

It has sometimes been thought that there may be a rate at which a person can receive radiation with reasonable safety as regards certain types of

direct damage to his own person. But the concept of a safe rate of radiation simply does not apply if one is concerned with genetic damage to future generations. What counts from the point of view of genetic damage is not the rate; it is the total accumulated dose to the reproductive cells of the individual from the beginning of his life up to the time the child is conceived.

Most of the attention has been devoted to the medical effects of large amounts of radiation, say 100 roentgens or more. Very large doses, for example more than 800 roentgens striking all or most of the body, would inevitably cause death. Less than lethal doses produce a variety of effects. The most prominent immediate ones are blood and intestinal disorders; leukemia and cancer are among the chief delayed effects. The skin is very sensitive to radiation.

The natural content of radioactive elements in foods now consumed by animals and man is not the same as in the pre-atomic age. Though extremely small, the difference is measurable and inescapable. It is believed that the slowly rising background of radiation caused by weapon testing in peacetime at the present rate is not likely to impair or interfere with food production. However, the levels which might result from atomic warfare or from mishaps with nuclear power plants in peacetime could have catastrophic effects on agricultural production.

In case of severe contamination the material causing most concern would be strontium-90. There appears to be no way of preventing its accumulation in bone tissue. All available foods grown in heavily contaminated areas might contain significant levels of radioactive strontium-90, perhaps for years. At present there is not known at what level food becomes unwholesome because of radioactivity.

Experiments to date indicate that irradiated foods do not become radioactive. This refers specifically to radioactivity and does not decide the question of probable toxic results from changes within the irradiated foods.

**Radiation Preservation of Food.**—It is desirable to utilize the potentials of machine-accelerated electrons as well as reactor-produced gamma radiation since data indicate that each type of radiation has its place and limitation. Intensive research leading to the industrial application of ionizing radiation to foods was not started until 1945, even though the bactericidal action of such radiation was known for a number of years. When particle accelerators were developed in the 1930's, a major source of controllable radiation energy was made available. Investigations were conducted to determine whether food containing viable bacteria could be sterilized by high energy x-rays produced by such particle accelerators. It was found that sterilization of highly contaminated foods could be brought about by these radiations.

Cold sterilization involves irradiating the food primarily by either beta rays (high speed electrons) or by gamma rays. It is called cold sterilization because the destruction of microorganisms is accomplished with only a small temperature rise.

The two major types of radiation that are of current interest are beta rays and gamma rays. The major difference in the effectiveness of the two types of radiation is that beta rays do not have much penetrating power unless very high voltage generators are used and are of primary value for surface sterilization of meat, while gamma rays have effective penetrating power and therefore would be applicable for both surface and interior sterilization of meat.

**Beta rays (cathode rays).**—Beta rays for commercial use are produced by high voltage generators. Most generators used in this work produce 1 to 5 million electron volts, although studies with larger generators are under way. With these beta ray producing machines, sterilization doses (1 to 3 million rep) in products are achieved in a matter of seconds and this rapid action is advantageous for continuous line operation. The low penetrating power of beta rays, however, limits the thickness of the sample that can be effectively sterilized. By irradiating from both sides with the use of a 5 million volt generator, for example, the maximum thickness of the sample of meat that could be sterilized effectively would be approximately 1 inch.

Actually the word sterilization as used here means what is sometimes called commercial sterilization. Although the treatment accomplishes a high degree of stability in the treated food not all organisms are killed and the enzyme systems are not destroyed.

Beta rays consist of a beam of negatively charged electrons accelerated by an electrostatic or electromagnetic field. The electrons are physically identical to negatively charged beta rays emitted by radioisotopes. But when accelerated by a constant potential beta rays can be made monoenergetic. The electron-beam energy limitations of direct accelerators are practical rather than fundamental in nature. Because the electrons must acquire their energy by acceleration from a high-potential region to ground, the beam energy can be no higher than the highest above-ground voltage that can be insulated practically.

Beta rays passing through matter give up energy through excitation, ionization, and radiation processes. In the radiation process, the electron energy loss is converted into production of $x$-rays. Energetic electrons are completely stopped by relatively small thicknesses of material, however, the sterilizing effect depends on the $x$-rays produced when the beta rays dissipate their energy in the food product, its container and surrounding materials.

While beta-ray machines can be converted to produce high energy $x$-rays comparable to gamma rays, a great loss in power efficiency occurs. Major attention at present, however, has been concentrated on the use of radioactive materials as a source of gamma rays for ionizing irradiation. An example is cobalt-60. Radioactive materials lose their potency with time which is disadvantageous. Radioactive cobalt-60, for example, will lose approximately 50 per cent of its effectiveness in a five-year period. Such a source of gamma ray, of course, cannot be turned off and on like beta-ray generators.

Effective doses of ionizing radiation for insects ranges from 100 to more than 10,000 rep. Dose levels for non-sporulating bacteria and molds range from 1,000 to 1,000,000 rep. Dosage effective against sporulating bacteria range from 10,000 to 1,500,000 rep. Dosage for viruses ranges from 1,000,000 to more than 10,000,000 rep and for enzymes the range is 1,000,000 to more than 100,000,000 rep.

From available information there appears to be a high correlation between biologic complexity and sensitivity to radiation injury. Also, the radiation sensitivity varies widely with different kinds of microorganisms and with their metabolic activity. Much higher levels of radiation are required, for example, to kill bacterial spores as compared to vegetative cells. Other factors that influence radiation sensitivity of microorganisms include population densities and other environmental factors. Results thus far, however, indicate that beta and gamma rays are equally effective in killing organisms within the range of their ability to penetrate.

By its very nature, radiation sterilization, that is, the destruction of microorganisms by exposure to streams of high-speed beta particles or gamma rays, can be expected to produce more subtle changes in molecular structure than heat sterilization. Investigators report that their use of the spectrum to detect new substances produced by radiation in trented foods shows an increasing number of such new substances depending on the degree of exposure to the ionizing irradiation. These changes probably derive from the action of the reducing and oxidizing systems, resulting from the ionizing radiation ns well as by direct change in molecular structure because of the bombardment of the molecule by the irradiation.

When materials containing water are irradiated with high voltage beta rays or gamma rays, free hydroxyl ions and free hydrogen ions nre produced. With these ions produced in irradiated foods, chemical changes will take place that may result in undesirable flavors, odors, and off colors.

The ionizing effects from irradiating a relatively simple system such as water produces a chemistry that is rather complex. It is understandable, then, that the resulting number of possible reactions becomes astronomical when complex foods such as proteins, fats, and carbohydrates are irradiated.

Reports state that the data obtained from animal-feeding experiments do not indicate any significant production of toxic compounds by radiation sterilization or preservation. The subtle nature of the changes brought about by irradiation, however, requires the extension of these studies for longer feeding periods in order to insure that foods sterilized or preserved by ionizing radiation may be safely consumed by human populations. Long-term feeding studies have been initiated and are considered to be the most important area of the testing work.

Research relating to the microbiological aspects of radiation preservation have revealed interesting results. A classical work on bactericidal effects of radiation, effects which have been adequately reviewed, postulates the destruction of bacteria as being due to direct hits at or near the sensitive portions of the organism. Under such a scheme, environmental changes should have no effect on the rate of destruction of the bacteria. Earlier

work indicated the destruction of *S. aureus* by ionizing energy to be due in part to the indirect action of the radiation on the medium, as it was observed that the more complex the medium in which the bacteria were suspended, the less the destruction of the organisms. Thus, the complex media components captured or neutralized the free radicals and protected the bacteria.

Further evidence of the indirect destruction of bacteria has also been recorded. It was observed that the survival of bacteria in milk irradiated at 40° to 45° F. was appreciably less than in milk irradiated in the frozen state. Thus, based on two entirely different environmental premises and two different theoretical bases, evidence is available to indicate the importance of the "indirect effect" via free radicals on the destruction of bacteria by ionizing energy.

It has also been observed that E. coli are more radiosensitive in the presence of oxygen than in its absence, and that environmental conditions during the development and growth of organisms as well as during irradiation, are of importance insofar as radiosensitivity of microorganisms is concerned.

Not all species of bacteria are more sensitive to ionizing radiation in the presence of oxygen; each species must be studied as a separate entity. For instance, B. thermoacidurans does not show this oxygen sensitivity.

Meat is particularly sensitive to ionizing radiation and sterilization dosages producing objectionable off flavors, off odors and discolorations. Although relatively small gross chemical changes occur in the product during sterilizing irradiation, profound changes occur in acceptability. Three major techniques have shown promise in this connection: (*a*) the addition of certain agents such as ascorbic acid that are more readily reactive with the free radicals produced in the food by the ionizing radiation (*b*) the use of low temperatures during irradiation (*c*) avoidance of the presence of oxygen in the sample or atmosphere during the irradiation process.

During storage chemical changes occur in foods that are not due to bacterial spoilage. Thus, even with sterilizing doses, certain enzyme systems are not inactivated and breakdown of fats, proteins, and other constituents may occur during storage to such an extent that the product would be unacceptable. It appears possible that a combination of mild heat to inactivate the enzyme systems and minimal irradiation doses may ultimately prove to be useful processing method.

Radiation flavor in meat is unique. It is generally associated with the protein components. While fats are affected, they do not give rise to the irradiated flavor. Evidence seems to be developing that the characteristic off flavor originates in proteins containing sulphur and more specifically in sulfhydryl groups. Compounds such as mercaptans and hydrogen sulfide may be associated with the irradiation flavor.

The nature of the heavy metal precipitates obtained with gases from irradiated meat indicates that sulphur-containing compounds contribute to some of the off odors that develop in meat during irradiation. The results obtained indicate hydrogen sulfide as one of the components and, on the basis of subjective odor comparisons, methyl mecaptan as another.

The results obtained with glutathione determinations show a considerable loss of glutathione and/or some other sulfhydryl compounds. Consistent with the results of these determinations are reports of the formation of hydrogen sulfide from irradiated solutions of glutathione and cysteine. Evidence indicates that hydrogen sulfide formation from cysteine is independent of the presence of oxygen.

Methionine would appear to be the logical source of the mercaptan.

Available information indicates that myoglobin is altered by irradiation treatment. It is reported that doses as low as 150,000 rep produced discoloration of meat. However, concentrated crude extracts of meat, when exposed to radiation doses ranging from 388,000 to 2,300,000 rep gave results which were not consistent. Extracts which appeared to be identical before irradiation became green, greenish-brown, brown, or purple, or remained red on irradiation. The red-brown color was due to a mixture of metmyoglobin and oxymyoglobin and the purple color, probably, was due to reduced myoglobin which, on exposure to air became oxygenated to oxymyoglobin. The green color, although interesting, was not explained. In some cases where the sample of meat was brownish before irradiation, it was a very good red color after irradiation. This apparently is due to the conversion of metmyoglobin to myoglobin which was then oxygenated to oxymyoglobin.

Irradiation processing of foods apparently effects some destruction of fat-soluble vitamins (vitamins E, A). The destruction of water-soluble vitamins is in general not as great by radiation sterilization as by heat treatment. Thiamine suffers the greatest destruction from radiation sterilization, of the order of 65 per cent at three megarep, a value comparable to the destruction resulting from current commercial cooking techniques. The pyridoxine content in radiation sterilized beef was found to be reduced by 25 per cent, whereas the reduction of pyridoxine in heat-treated beef is reported to be 30 per cent. Niacin is relatively resistant to radiation sterilization by contrast to heat treatment. The other water-soluble vitamins such as riboflavin and folic acid do not exhibit appreciable destruction whereas losses due to heat sterilization occasionally amount to 35 per cent.

The peroxide content of meat fats increases during irradiation particularly in the presence of oxygen. Peroxide produces faster in irradiated fats during refrigerated storage in the presence of air than in non-irradiated fat controls. Carbonyl compounds and free fatty acids were found to have increased in fats during irradiation and storage in air.

Pseudomonas are the major spoilage microorganisms present in fresh beef and are relatively radiation-sensitive. Dosages under 100,000 rep have been used successfully to prolong the shelf life of beef kept under refrigeration. Beef treated with such low levels of radiation shows no evidence of damage with respect to odor, flavor, or color. The common spoilage microorganisms for cured meats, however, are much more radiation resistant. Therefore, the same low level of radiation treatment which has been used successfully for fresh meat is not effective to prolong the shelf life of cured meats.

Increases in peroxides, carbonyl compounds, or free fatty acids were small in beef and pork fat irradiated at 2 to 4 million rep when the presence of oxygen was minimized. A marked increase in peroxide values was observed when irradiated fats were stored at 5° C. in an oxygen-permeable casing as compared to non-irradiated fats stored in a like casing, and irradiated and non-irradiated samples in an oxygen-impermeable casing or in sealed cans. A lower peroxide value was observed when treatment at 4 million rep was used compared to 2 million rep for non-rendered fat irradiated in cans. Peroxide values for dosage treatments decreased and the free fatty acids increased during storage of the samples in cans at 24° C.

There is no residual radioactivity in the food irradiated at sterilizing doses of 2 and 3 million rep. The radiation just goes through it. It is like a person taking an *x*-ray. After he leaves the *x*-ray machine he does not have any *x*-rays in him. Those that have not penetrated the particular tissue but have bumped into a particular molecule dissipate their energy in changing that molecule into another molecule, in killing the bacteria, generating off-flavor, or causing other transformations. The fact that small changes can and do occur as evidenced by flavor, odor, and color changes gives rise to the thought-provoking question of whether structural changes in certain molecules due to irradiation might produce compounds unfavorable to health. Thus, the question may be posed whether possible subtle changes in a relatively few molecules of a food or drug could result in products that are in any way harmful.

**Atomic Attack.**—In the event of an atomic attack, meat food products and materials and facilities used by the meat packing industry would be exposed to ionizing radiation and radioactive fall-out. In such an emergency, the exposed meat food products would be needed for food. The exposed materials and facilities would be needed for the slaughter of animals and the preparation of meat and meat food products. It is important to determine whether or not products exposed to a nuclear detonation can be consumed without fear of harmful effects and how the palatability and nutritive value of the exposed meat food products are affected.

At Mercury, Nevada, meat food products were exposed to a nuclear device that had an energy release equivalent to 20 kilotons of TNT. At a distance of 1100 feet from ground zero, pressures of from 30 to 50 pounds per square inch were developed. At this distance the neutron flux was between 10 to the 11th power and 10 to the 13th power per square centimeter. The gamma flux was between 30,000 and 50,000 r.

The meat products were placed at three different distances from ground zero, 1100, 3300, and 5280 feet. Products placed at the near and intermediate distances were left in wooden shipping containers varying in depth from 3 to 6 inches and made of $\frac{3}{4}$ inch plywood.

Placing the products at a point where they would be exposed to ionizing radiation also exposed them to severe blast and thermal effects. The 3 inches of soil with which they were covered to provide protection from the blast and heat provided little sheltering from the ionizing radiation.

Samples at 5280 feet from ground zero were recovered twenty-seven hours after the detonation. There was no evidence of physical damage to the product although slight charring of boxes, wrappers, and cartons was

noticed. The samples at this distance from ground zero showed no induced radioactivity or radioactivity due to fall-out or drop-out. The odor of the product was uneffected by the detonation. The flavor of the lard was not affected, but the other products were not tasted.

Samples at 3300 feet from ground zero were also recovered twenty-seven hours after detonation. Although measurements of radioactivity showed the samples (except lard) to be very slightly above background, the amount was considered to be insignificant. There was no organoleptic change noted which could be attributed to the results of the nuclear detonation.

Samples at 1100 feet from ground zero were recovered fifty-two hours after the detonation. There was no physical damage to the product or immediate containers; however, the tops of several boxes were pushed in. There were no apparent defects in the odor, taste, or appearance of the product which could be attributed to the results of the nuclear detonation. Detectable induced radioactivity persisted up to and beyond one hundred hours after the detonation. Because the radioactivity declined rapidly initially and because of the sodium chloride content of the product, it can be assumed that the induced radioactivity was probably caused by sodium converted to the radioactive species Na24. Lard showed no significant level of induced radioactivity. The salt and curing mixture showed relatively high levels of radioactivity.

Chemical examination of the product exposed at 1100 feet revealed no changes in protein, moisture, or salt content. The results of these tests indicated some destruction of riboflavin in products exposed at 1100 feet. The thiamine was apparently unaffected.

There was no organoleptic evidence of rancidity in the lard or fat from the bacon. Increases in the peroxide values which were slight in the lard and somewhat greater in the bacon fat indicate the possibility that exposure to ionizing radiation has a tendency to promote the development of rancidity. The yellow color which developed in the exposed iodized salt was not explained. No free iodine was demonstrated and after exposure of the salt to the air for several hours, the yellow color disappeared.

Another lot, consisting of fresh meat and cured meat was exposed to a nuclear device with an energy release equivalent to 30 kilotons of TNT. These products were placed in tin-lined felt-insulated containers approximating 22 × 12 × 32 inches inside dimensions.

For this test, samples were placed in a trench at 1270 feet from ground zero and covered with 3 inches of soil. Samples were also placed in a concrete garage at 4700 feet from ground zero.

After the blast the containers at 4700 feet were recovered twelve hours after the detonation, and the containers at 1270 feet were recovered at fifty-five hours after the detonation. The containers of product exposed in the concrete garage were only slightly damaged by the blast and no effects on the meat products were detectable. None of the product in this location exhibited any radioactivity.

The containers of product exposed below grade at 1270 feet from ground zero were caved in from the top and small amounts of sand were blown into the containers. All products exposed at this position exhibited radioactivity when recovered. The amount of activity was related to the type

of product and the distance below grade level in the containers. Cured meat products exhibited more activity than fresh meats, probably due to the salt content. Meats near the top of the container were more radioactive than similar meats near the bottom; for example, beef sirloin near the top showed a count of 13,000 per minute at sixty hours following detonation, whereas beef round had a count of only 1,000 per minute being located a greater distance below grade level. In the same piece of meat, bone was more radioactive than lean tissue, which in turn was more radioactive than fatty tissue. In all products the radioactivity decayed approximately 50 per cent every twenty-four hours.

Exposed samples of beef round and pork loin contained slightly more hydrogen sufide, carbonyl compounds, and glutathione than unexposed samples. It was concluded that fresh and cured meat products exposed to an atomic explosion would be acceptable for emergency feeding as soon as the induced radioactivity level dropped to a safe point, provided, of course, that bacterial spoilage had not occurred in the meantime.

One important observation was stressed; the radioactivity of a container was never conveyed to the contents. Extremely radioactive glass jars, for example, could be emptied of the contents which would be found to be be only feebly radioactive. This means that in monitoring foodstuffs after a nuclear attack, judgments of suitability should not be based on readings taken on the container alone.

Strictly speaking, it was pointed out that the findings presented in the foregoing are applicable only to the size of the nuclear detonation used in the Nevada experiment. The question naturally arises as to whether any of the above information would prove useful in evaluating the effects produced by a super device of the thermonuclear series. It was estimated that the findings might be applied qualitatively, provided the scale of distances used in this test are multiplied by an appropriate factor. Thus, it is possible that the critical area in a thermonuclear explosion may be 3 to 5 miles or more in diameter and that on the fringe of this area comparable exposure conditions as here noted might apply.

**Research Findings on Radioactive Fallout.**—The radioactivity produced by the fission reaction being due to a mixture of many different fission products, changes its characteristics continuously and rapidly following release by the bomb detonation. Since the time required for ingestion into the body is long, ingestion is unlikely for the shorter-lived fission products and therefore the principal hazards for close-in fall-out are radiation exposure by gamma radiation of the whole body and by beta radiation on the skin.

Weeks and months after the explosion, the ingestion hazards begin to become important. The most serious of these is the high-yield fission product, radioactive strontium (Sr. 90), because of its own radiation and that of its short-lived daughter, yttrium-90 (Y 90), and because of its chemical similarity to the bone-building element, calcium, finds itself deposited in bone structure. Other radioactive materials produced would be as bad if they spent as long a time in the body, or if their radioactive lifetime were long enough or if they were produced in high-yield. Strontium has all of these characteristics. So, for the fission products which have

survived the first weeks, the most important fall-out constituent and the one most seriously to be considered is radioactive strontium (Sr. 90). Neither Sr. 90 or Y. 90 emits gamma radiation but only betn radiation. After the first year, cesium-137 with a 33-year half-life, is the principal source of the residual gamma radiation, and any gamma radiation exposures due to fission products which are more than one year old are due very largely to radioactive cesium. The other isotopes either constitute no ingestive hazard or fail to emit gamma radiation in appreciable intensity. So, the hazards of world-wide fallout reduce themselves largely to the ingestive hazard of radioactive strontium and the external exposure from radioactive cesium. Strontium-90, Cesium-137 and the rare earths comprise nearly all of the long half-life fission products that might be of concern to man. The rare earths, so far as is known, play no vital roles in the nutrition of plants or animnls.

The chemical and physical properties of strontium are closely related to those of the essential element calcium. A consideration of the fate of the fission product strontium-90 in the earth's geochemical and physical processes becomes a study of the behavior of calcium and the degree to which the heavier strontium ion may lag behind its lighter counterpart, calcium. The strontium-90 ions become a part of n reservoir of calcium and strontium ions that nre nlmost nlike to the plant and nnimal. They are similar, not necessarily identical.

Calcium nnd strontium do not readily move downward in the soil by leaching with rainwater. It is impractical to move strontium-90 from the root zone of n crop plant by n leaching process.

The fall-out on lakes, rivers, nnd oceans is mixed with the relatively large volumes of water and hence is not so concentrated as the fall-out that lodges in the tap few inches of soil. The strontium-90 eventually fiads itself on the bottom of lakes or in the mud of rivers. In moving waters it becomes adsarbed to the sail or rack particles.

The strantium-90 is largely removed by filtration from waters in wells and springs. In any case, it can readily be removed from drinkiag water by water softeaers or ion exchaage resias. Foad supplies can be seriously contaminated by strontium-90. This applies bath ta contaminatioa direct by fall-out on the food and that which becomes a part of plants either by uptake through the plant roots or by assimilation through the leaves.

Strontium is readily absorbed from the gastroiatestiaal tract, althaugh somewhat less readily than is calcium. For the most part, it is accumulated in the crystalline miaeral portion of bones similar to calcium. The skeletal deposition of ingested strontium occurs predomiaantly at sites of active bone growth and bone tissue reforming. It is potential cause of bone cancer and damage to the blood-forming tissues.

By contrast with plants, vegetables, and milk, in which strontium-90 may be expected to be fairly uniformly distributed throughout the product, the strontium-90 contamination of the feed of animals being deposited in the bone can be eliminated from the carcass by discarding the bones and using only the boneless meat for food.

The behaviour of cesium-137 is related to that of the quite common essential plant and animal growth element, potassium. Cesium and potas-

sium differ materially from strontium and calcium in their chemical behaviour in the soil. Plants take up but little cesium from the soil.

Cesium-137 is of interest principally to the extent that it is deposited directly on foodstuffs or gets into the water supply. Natural filtration removes it from the waters in wells and springs.

Cesium-137 becomes distributed in the body similarly to the essential nutrient element, potassium. It occurs in muscle tissues, other soft tissues, and the blood. The rate of clearance of cesium from the body is relatively so high that the continuous ingestion of substantial amounts from water and food is required to maintain a high body burden.

## Chapter 17

# ORGANIZED MEAT HYGIENE CONTROL

MEAT Inspection (including Poultry Inspection) is the term commonly used to designate the activity that applies the controls necessary to enforce the principles of meat hygiene at a packing plant. In fact, meat inspection is essential to meat hygiene because, generally, meat hygiene is not practiced in a packing plant without meat inspection control. That this inspection must be an official one to be effective has been recognized since before the time of Moses. In more recent times, President Theodore Roosevelt in his message of June 4, 1906 to the United States Senate and House of Representatives summed up the findings of extensive investigations of conditions in meat packing plants in large meat packing centers in the United States by saying, "A law is needed which will enable the inspectors of the General Government to inspect and supervise from the hoof to the can the preparation of meat food products." That year saw the enactment of the Federal Meat Inspection Law under which Federal meat inspection is still conducted.

Organizing a meat inspection agency requires a consideration of the objective of such an agency to identify the points at which controls will be applied. The objective is, of course, a clean, wholesome, disease-free meat supply that is not adulterated or mislabeled. To gain this objective only healthy food animals and poultry should be converted to meat, diseased and otherwise unfit carcasses and parts of carcasses should be eliminated at the time of slaughter, the meat and its products should not be adulterated, diseased or otherwise unfit meat or products should be destroyed for food, the meat and its products should not be mislabeled, and environmental sanitation should be observed in the handling of the meat and its products. Meat inspection is organized in such a way as to apply its controls to accomplish these objectives. The inspectors, who are assigned to conduct examinations of food animals and poultry before they are slaughtered and their carcasses at the time they are slaughtered, must have the educational background that will enable them to identify and evaluate disease processes as they have a bearing on the fitness of the meat for food. Under the educational system as it is organized in the United States, courses of study that will provide this educational background are available only in college work leading to the degree of Doctor of Veterinary Medicine. Accordingly, in the United States, only veterinarians receive the kind of training that enables them to make final determinations with respect to the fitness of animals or their carcasses for the preparation of meat for human consumption. In organizing a large meat inspection group it has been found to be possible to use laymen to assist veterinarians in the conduct of ante-mortem

and post-mortem examinations. These laymen function under the immediate supervision of veterinarians. Laymen are also used to apply controls which relate to destruction for food of diseased or otherwise unfit meat or its products, adulteration, mislabeling, and environmental sanitation.

Assuming the organization of an effective meat inspection agency, its function depends on its basic powers to act. These are determined by the wording of the legislation that brings the agency into being and its jurisdiction depends on the governmental level at which the legislation was enacted. A model ordinance published by the American Veterinary Medical Association is given on page 498 of the Appendix. The Federal Meat Inspection Act which has served effectively as legislative background for organizing the Federal Meat Inspection Service is given on page 505 of the Appendix. The new Federal Poultry Inspection Act is given on page 510.

The jurisdiction of the meat inspection agency is its power or right to exercise authority within the scope of the legislation that sets up the agency. In this connection it is desirable to review briefly the organization of the Government of the United States. It is a combination of two Governments, national and state, with different spheres of action, each supreme and independent in its own sphere. Neither is vested with complete powers but the two operating together discharge all the proper functions of Government. The Constitution of the United States establishes and limits the powers of the national or Federal Government. The Federal system of Government thus established is necessarily a complicated one. It is useful to observe the distinction made by Justice Story in the case of Martin v. Hunter's Lessee decided in 1816 that "The Constitution of the United States was ordained not by the states in their sovereign capacities but emphatically as the preamble of the Constitution declares by 'the people of the United States.' . . . The Constitution was not, therefore, necessarily carved out of existing state sovereignties, . . . . On the other hand, it is perfectly clear that the state powers vested in the state governments by their respective constitutions remain unaltered and unimpaired except so far as they (powers) were granted to the Government of the United States. The Government, then, of the United States can claim no powers which are not granted to it by the Constitution and the powers actually granted must be such as are especially given or given by necessary implication."

State Department of Agriculture, through its Director, is charged with the responsibility of enforcing the Agricultural Code which includes provisions pertaining to meat inspection. The Division of Animal Industry of that Department administers the state meat inspection program as one of its several activities.

The Department is authorized by the Agricultural Code to approve and supervise municipal systems of meat inspection. This brings a municipal organization within the control of the state organization.

The organization of the meat inspection service of the State of California and its function are quite similar to the Federal Meat Inspection Service. Therefore, the description of the latter service which follows will serve also for the state organization. This, of course, does not apply to the controls exercised by the Federal Service over interstate shipments of meat, and exportations and importations of meats, which functions are peculiar to the Federal Service. The chart shown in figure 125 illustrates the meat inspection coverage in the State of California as applied by approved municipal inspection, state inspection, and Federal inspection.

The following description of the Federal Meat Inspection Service also identifies the basic areas of functional responsibilities serviced by the Federal Poultry Inspection Service. The Poultry Inspection Service is not described here in detail because differences in organization between that Service and the Meat Inspection Service are procedurally and substantively similar.

**Federal Meat Inspection.**—The Secretary of the United States Department of Agriculture is given the responsibility to administer the Meat Inspection Law and he is authorized to promulgate regulations that will implement the law and enable him effectively to administer its provisions. Briefly, the inspection program consists of examination of food animals and of their carcasses at the time of slaughter; inspection at all stages of the preparation of meat and meat food products to assure sanitary handling; destruction of condemned product to prevent its use for human food; examination of all ingredients used in the preparation of meat food products to assure their fitness for food; prescribe and apply standards of identity to inspected meat food products; enforcement of measures that insure informative labeling; prohibit the use of false and deceptive labeling; inspection of foreign meat and meat food products that are offered for importation; and administer a system of certification to assure acceptance of domestic meats and meat food products in foreign commerce.

The inspection program is extended to a meat packing plant at the request of the plant management which has decided that it needs inspected meat for interstate commerce. An application is made out by such packer who is then informed what plant and inspection facilities will be required before the inspection is inaugurated. Having met the requirements, inspectors are assigned to the plant and the system of inspection is applied to the plant in accordance with the inspection provisions of the law and the regulations promulgated thereunder.

As the inspection program developed following 1906, it became apparent that litigation involving the program would consist for the most part of those cases that are brought by the Government against interstate shippers

| Inspection Departments | Cattle Insp'd | Cattle Cond. | Calves Insp'd | Calves Cond. | Sheep Insp'd | Sheep Cond. | Swine Insp'd | Swine Cond. | Goats Insp'd | Goats Cond. |
|---|---|---|---|---|---|---|---|---|---|---|
| Approved Municipal Inspection | 12,381 | 21 | 2,006 | 14 | 112,152 | 111 | 22,099 | 52 | 208 | — |
| State Inspection | 265,633 | 1,349 | 197,840 | 639 | 301,175 | 1,320 | 179,538 | 390 | 1,697 | 26 |
| Federal Inspection | 1,170,308 | 4,015 | 417,016 | 7,449 | 1,716,519 | 11,257 | 1,528,140 | 4,769 | 169 | 3 |
| Total Inspected Slaughter | 1,448,322 | 5,385 | 617,152 | 8,102 | 2,133,116 | 12,988 | 1,729,777 | 5,211 | 2,374 | 29 |
| *Estimated Uninspected Slaughter | 29,000 | | 19,000 | — | 80,000 | — | 89,000 | — | — | — |
| Estimated Total | 1,477,322 | 5,385 | 636,152 | 8,102 | 2,213,116 | 12,988 | 1,818,777 | 5,211 | 2,374 | 29 |

* Estimated uninspected slaughter includes the following:
Animals slaughtered on farms.
Animals slaughtered in uninspected slaughtering establishments located in counties of less than 28,000 population, in which compulsory meat inspection is not operative, and establishments operating under inspection exemption in other counties.

FIG. 125.—Number of Animals Slaughtered at Federal, State and Municipal Inspected Establishments in 1948, and Number of Whole Carcasses Condemned, also Estimated Number of Animals Slaughtered in Uninspected Establishments and on Farms, and Estimated Total Number of Animals Slaughtered for the State of California.

| Kind of Animal | Antemortem Inspection: Passed | Suspected | Condemned | Total | Postmortem Inspection: Passed | Condemned | Total |
|---|---|---|---|---|---|---|---|
| Cattle | 19,578,801 | 101,167 | 2,601 | 19,682,992 | 19,600,757 | 79,141 | 19,679,898 |
| Calves | 7,599,509 | 6,592 | 906 | 7,607,007 | 7,560,803 | 39,215 | 7,600,018 |
| Sheep | 11,201,801 | 1,962 | 605 | 11,209,371 | 11,149,467 | 59,185 | 11,208,652 |
| Goats | 85,710 | 20 | 0 | 85,730 | 85,182 | 551 | 85,736 |
| Swine | 68,709,151 | 71,168 | 1,621 | 68,781,940 | 68,660,880 | 119,034 | 68,779,020 |
| Horses | 179,462 | 69 | 6 | 179,537 | 178,666 | 865 | 179,531 |
| | 108,353,506 | 187,278 | 5,799 | 108,546,583 | 108,241,761 | 297,994 | 108,539,755 |

FIG. 126.—Antemortem and Postmortem Inspection of Animals, Fiscal Year 1950, Under Federal Meat Inspection.

of uninspected meat. Information on which these cases are developed is furnished for the most part by members of industry whose business is affected adversely by the competition which involves the violation of the law. There are a few such cases each year involving small marginal oper-

| *Product* | *Pounds* |
|---|---|
| Placed in cure: | |
| Beef | 168,474,988 |
| Pork | 3,704,683,088 |
| Other | 1,627,209 |
| Smoked and/or dried: | |
| Beef | 57,064,186 |
| Pork | 2,637,948,995 |
| Cooked meat: | |
| Beef | 79,768,828 |
| Pork | 312,782,389 |
| Other | 3,944,622 |
| Sausage: | |
| Fresh finished | 238,389,759 |
| To be dried or semi-dried | 141,755,135 |
| Frankfurters, wieners | 633,253,242 |
| Other | 619,392,336 |
| Loaf, head cheese, chili con carne | 206,697,935 |
| Steaks, chops, roasts | 701,045,249 |
| Meat extract | 1,901,226 |
| Sliced bacon | 998,599,496 |
| Sliced other | 165,257,932 |
| Hamburger | 163,467,760 |
| Miscellaneous meat product | 71,865,176 |
| Lard: | |
| Rendered | 2,186,136,855 |
| Refined | 1,657,600,508 |
| Oleo stock | 108,575,896 |
| Edible tallow | 185,131,543 |
| Rendered pork fat: | |
| Rendered | 115,007,109 |
| Refined | 62,858,489 |
| Compound containing animal fat | 578,097,254 |
| Oleomargarine containing animal fat | 54,077,612 |
| Canned products | 2,307,406,746 |
| Horse meat products: | |
| Cured | 4,543,010 |
| Chopped | 20,053,480 |
| Canned horse meat | 18,989,969 |
| Total | 18,207,298,082* |

*This figure represents inspection pounds. Some of the products may have been inspected and recorded more than once on account of their having been subjected to more than one processing treatment, such as curing first and then canning.

FIG. 127.—Meat and Meat Food Products Prepared and Processed under Supervision, Fiscal Year 1956, under Federal Meat Inspection.

ators and the illegal traffic is of little consequence. For the most part, meat is such a highly competitive item that there is little incentive to traffic illegally in the product.

The other class of litigation is that which would test the Secretary's authority under the law and is made up of a few historic cases in which

affected parties requested restraining orders directed at the Secretary. Those basic inspection routines connected with the ante-mortem and post-mortem examinations of food animals and sanitary controls have never been questioned. Although these routines are applied meticulously to the entire production of the inspected portion of industry and are integrated into the production lines with condemnations totalling considerable cost, these routines and their application by inspectors have been recognized, in the first place, as being contemplated by the law and, in the second place, as being those that are reasonable to accomplish its objective.

The requests for restraining orders have been directed toward such things as just what products come under the inspection requirements, the power of the Secretary to establish food standards, and the extent of the Secretary's label control powers.

The law is clear that the inspection controls apply to food animals and their carcasses and it is also stated that the inspection applies to meat food products prepared from such carcasses. Three early cases clarified the meaning of meat food products.

In Armour and Company *vs.* United States[1] decided by the Circuit Court in 1915, it was decided that a boiled ham prepared by Armour and Company at its Pittsburgh plant from a ham that had been produced, cured, boned, and tied at its inspected Chicago plant would have to be prepared under inspection control at the Pittsburgh plant if it were to be shipped interstate in compliance with the Meat Inspection Law.

In the Pittsburgh Melting Co. *vs.* Totten[2] decided by the Supreme Court in 1918, it was held that oleo oil, a substance made from the fat of slaughtered beeves seldom used by itself as food, but employed largely in making oleomargarine and somewhat in cooking, is a "meat-food product" within the Meat Inspection Act when manufactured fit for human consumption and not denatured, and is debarred from interstate and foreign commerce unless first inspected and passed as provided by the Act. The court held that this applies whether the shipper labeled the product "inedible" asserting it was not intended for food purposes.

In Brougham *vs.* Blanton Manufacturing Company[3] the Supreme Court decided in 1918 that oleomargarine may be classed as a meat food product subject to the meat inspection law.

**Standards of Identity for Meat Products.**—Sausage has always been a highly competitive product in the meat field. Being a chopped, manufactured product it lends itself easily to substitution of such materials as cereals and water for meat. Sausage, therefore, served as a good example of a manufactured meat food product to test the Secretary's authority under the law to set food standards. The Secretary's regulations that limited the amount of cereal and water as ingredients of sausage products were challenged in the courts. In the Houston *vs.* St. Louis Independent Packing Company[4] case decided by the Supreme Court in 1918, it was held that under the Act, the Secretary of Agriculture is authorized to prohibit the use of the word "sausage" as false and deceptive when applied to a compound of meat with added cereal and water exceeding allowable

[1] 222 Fed. 23 [2] 248 U.S. 1 [3] 249 U.S. 495 [4] 249 U.S. 967

amounts. The court held further that the Act does not require the Secretary to mark a meat food product "inspected and passed" merely because it is wholesome and free from dyes and chemicals, if it is sold under a deceptive name. Whether the name "sausage" is deceptive as applied to a compound of meat with added cereal and water, the court said it is a question of fact which the statute submits to the determination of the Secretary under the power it gives him to make rules and regulations for carrying it into effect, and his decision, when fairly arrived at on substantial evidence, is conclusive.

From time to time as there is a clearly demonstrated need, standards of identity have been established for many meats and meat food products. In addition to the great variety of sausages, standards have been identified for such products as soups, meat pies, luncheon meat, chili con carne, corned beef hash and many others. The standards are expressed in simple terms covering such things as minimum meat requirement and maximum allowable moisture.

**Labeling.**—An oleomargarine label furnished the test of the Secretary's authority concerning labels. The label control provisions of the Act are rather complete in their coverage. No label is permitted to be used by the inspected packer until it has been approved under the inspection program. The inspector will not permit a label to be used unless it had been previously approved by the label review office of the Meat Inspection program, and only then when the product conforms with the terms on the label. Approval is withheld from a label which is false or deceptive. In Brougham *vs.* Blanton Manufacturing Company (supra) it was decided that under the Meat Inspection Law, the power to determine whether a trade mark is false or deceptive is lodged in the Secretary of Agriculture and his determination, if not arbitrary, is conclusive. In this connection the court went on to say that the power of the Secretary is a continuing one and the approval of a name at one time dose not preclude a disapproval later. It went on to say that the Secretary having approved the name "Creamo" as a designation of an oleomargarine containing 30 per cent cream and which was strongly extolled on that ground was amply justified denying the use of that term, when the cream had been greatly reduced or omitted and replaced by skimmed milk, notwithstanding evidence that the manufacturer invested heavily upon the faith of the approval. It held further that the registration of a trade mark under trade mark law has no bearing on the right to use it under the Meat Inspection Law.

**The Mark of Inspection.**—As might be expected, the mark of inspection itself has come in for considerable attention. Obviously, the mark must be protected, since it is relied on for many purposes as evidence of a product having been prepared under the inspection provided by law. The courts have been quick to recognize this and as a result the program has been successful in effectively controlling unauthorized use and even careless and inadvertent improper use of the mark of inspection.

In United States *vs.* Lewis[1] decided by the Supreme Court in 1941, the court held that the plain object of the prohibition in the Meat Inspection Law against alteration or destruction of tags and labels bearing the marks

[1] 235 U.S. 282

of inspection is to safeguard food products against alteration and substitution so as to render the process of inspection effective and the statute will not be construed as to defeat the purpose for which it was passed.

In Armour and Company *vs.* United States (supra) the court held, speaking of the mark of inspection, that the Act impliedly promises the public that Government stamps and labels may be relied on to tell the truth and therefore special care must be taken to maintain the scrupulous accuracy of their statements. It went on to say even innocent mistakes may have dangers; carelessness is usually likely to lead to mischief. The court said further that these marks and labels must therefore be protected and no one must be allowed to use them except in accordance with the Act and Regulations; otherwise their value will be immediately impaired or lost and a chief purpose of the act will be frustrated.

During 1956 there were approximately 1,200 federally inspected meat packing plants located in 450 cities and towns throughout the United States. These establishments were organized into 150 meat inspection stations, each headed by an Inspector in Charge. A few of these stations consisted of a single meat packing plant which because of its location did not lend itself to grouping with other establishments to form a larger station. The meat inspection stations range in size from those containing a single establishment to the large Chicago station containing 75 establishments. Figures 126 and 127 illustrate the volume of animals and product subject to Federal meat inspection.

The entire United States is divided into 4 areas with the stations in each area coming under the supervision of an Assistant Director. The 4 Assistant Directors along with the Director of the Meat Inspection Service and his other Assistants make up the organization's central office with headquarters in Washington, D.C.

The Washington office is divided into functional units namely, Special Projects, Trade Labels, Inspection Procedures, Inspection Facilities, and the Laboratories. Each unit formulates the policies within its particular area of responsibility and sees that the policy is applied uniformly throughout the country. This is accomplished through the personal contact maintained between the central office in Washington and each inspected establishment.

**Special Projects.**—In this unit is administered that part of the meat inspection program that relates to interstate movement of meat, importations, exportations, farmer and retail dealer exemptions, and violations of the Meat Inspection Act.

Through a system of certifications, responsibility is established in connection with the interstate movement of meat. It is provided by the meat inspection regulations that the interstate carrier of meat shall request and the shipper of such meat shall furnish a certification in the form prescribed by the regulations. The certificate identifies the meat being offered for shipment in interstate commerce and states that it conforms with the law.

The control of importations of meat is calculated to assure that the meats that are brought into the United States from foreign lands have been subjected to the same controls as meats in the United States that are

subject to Federal legislation. A country which desires to send its meats to the United States requests that its sytem of inspection be accepted as being comparable to that maintained by Federal meat inspection in the United States and asks that its certificates be accepted by the Federal Meat Inspection Service as evidence of such inspection. Investigations are then made to ascertain whether the inspection of the foreign country is, in fact, comparable to that maintained in the United States. If it is found that the foreign inspection is a satisfactory one, arrangements are made to provide a system of certification whereby each arrival at a port in the United States of a shipment of meat from that foreign country will be identified as to its inspectional background. If upon inspection by the Federal Meat Inspection Service the meat is found to be sound and wholesome, free from adulteration, and properly labeled, it is permitted to be brought into the United States.

Exportations of meat from the United States are covered by certificates of inspection that are recognized in all foreign countries. A vessel is not permitted to clear a port in the United States with a consignment of meat for a foreign country unless the meat is identified by export stamps or an export certificate evidencing the fact that it had been prepared under Federal meat inspection. One of the accomplishments of Federal meat inspection and its system of export certification is to assure free movement of American meats in foreign trade.

The Federal Meat Inspection Act provides that farmers and retail dealers need not have their products inspected. However, they are subject to the other requirements of the law which prohibit interstate movement of unfit, adulterated, or mislabeled meats. A system of licensing has been worked out to maintain the necessary control over retail establishments that take advantage of the exemption provision contained in the law. This makes effective the basic elements of the statute at retail establishments engaged in interstate commerce.

Special Projects uses the services of meat law investigators who are strategically located throughout the country to detect and investigate violations and suspected violations of the law. When a violation of the law has been committed, a case is prepared by this section and appropriate steps are taken for the prosecution of the offender.

**Trade Labels.**—The inspected meat packer is permitted to use only those labels and marking that have been previously approved by the Meat Inspection Service. This unit performs the label review function which assures that each label contains the required labeling information, that it contains no misleading feature, and that it is appropriate for the product on which it is intended to be used.

It is through the activities of this unit in limiting the use of a label to the product for which it is applicable that standards of composition for the many processed meat food products are promulgated and enforced. When a label is presented for approval, assuming that it contains all the required labeling information and that it bears no misleading feature, the name of product on the label is appropriate only for a particular food. When the meat packer is informed that the label is approved for that particular food, he is informed concerning the requirements for its composi-

tion. Also, the inspector is informed so that he can supervise the preparation of the product to make certain that it conforms with the standard.

**Inspection Procedures.**—This unit is responsible to see that the procedure used by each inspector in his inspection routine at a meat packing plant is adequate for the protection of the public meat supply and, at the same time, is that minimum which is necessary to accomplish results.

New and changed processes and methods are constantly being proposed for use by the inspected meat packer. These are evaluated in terms of the adequacy of current inspection procedures to meet the changed situation. Also, it is necessary to review existing practices to make certain that the necessary controls are being applied at all times.

Not only must procedures be identified that are necessary to accomplish the desired results, but these procedures are applied uniformly by all of the inspectors in all of the inspected meat packing plants throughout the country. This requires constant attention and review because of two very significant variables, one the human element and the other differences in plant facilities as between establishments.

**Inspection Facilities.**—All those factors relating to environmental sanitation and facilities for inspection are the responsibility of this unit. An applicant for the inspection is required to present to this unit for its review and approval complete plans of his plant, equipment, and facilities. These plans are reviewed to determine whether the plant in which it is requested that inspection be maintained will provide a satisfactory environment for the inspection and handling of product. When the plant is found to be acceptable the plan is approved and the inspection is inaugurated.

Changes and additions to existing plants in which inspection is being currently maintained are also reviewed by this section. Such changes and additions are made only after the plans for their installation have been approved. The installation is required to be made in accordance with the approved plan.

Specifications for equipment and plant layout are drawn up by this section for use as guides by managements of inspected plants and applicants for the inspection. Investigations are made of materials currently in use and of new materials to ascertain their suitability for food contacting surfaces and structural environment that have a bearing on food sanitation.

*Biological Control Laboratory.*—This unit serves the Meat Inspection program's needs that require both planning and laboratory work in the fields of bacteriology, pathology, parasitology, and serology. The veterinarians on ante-mortem and post-mortem inspection assignments look to this laboratory for servicing in a wide range of pathology and parasitology. These men send to the laboratory a constant stream of specimens consisting of abnormal and diseased tissue for gross and histologic study and a report on findings. Bacteriological studies are made of products and in connection with an evaluation of processing methods to determine their adequacy and safety. Such studies are also made to determine the adequacy of practices and procedures employed throughout the meat packing plant to determine the level of environmental sanitation. Serological methods and tests are developed for the purpose of detecting adulteration as, for example, the misrepresentation of beef to which horse meat has been added.

Industry demands on a meat inspection program in terms of the science of bacteriology have increased considerably in recent years. This results from industry's stepped-up activity in research and development connected with new products, new processes, new processing materials, and new packaging materials. The Biological Control laboratory must be prepared to outline and identify programs of investigations for the testing of new products and procedures.

**Chemical Control Laboratory.**—This unit services the field meat inspection program through its seven field laboratories. Samples of meat food products and a wide range of ingredients that are used in the manufacture of meat food products are forwarded by inspectors to the laboratory for chemical and physical evaluation. The reports furnished by these laboratories to inspectors in connection with such samples enable inspectors to decide concerning the acceptability of both the products and ingredients under the meat inspection regulations.

The seven field laboratories are located strategically throughout the United States, and there is a central laboratory located in Washington, D. C., which gives direction and instruction to the field units. This central office reviews analytical methods currently employed to determine their suitability. Also, new analytical methods are developed to meet changing requirements. This laboratory maintains a close working relationship with the Association of Official Agricultural Chemists. In fact, the Chief of the Laboratory serves as a Referee in the acceptance and recognition of new and improved methods by this Association. These methods are recognized officially by all Federal, State, and local food control officials and also by the courts.

**The Association of Official Agricultural Chemists.**—The Association of Official Agricultural Chemists, more familiarly known as the AOAC, is the professional organization of State and Federal chemists devoted to developing, testing, and sponsoring improved methods for the analysis of fertilizers, soils, foods, feeds, pesticides, drugs, cosmetics, caustic poisons, and other materials related to agricultural pursuits. It was organized in 1884 by the State and Federal chemists who were in charge of enforcement of State fertilizer laws, or who, as members of agricultural experiment stations or the U. S. Department of Agriculture, were interested in practical and scientific applications of fertilizers to crops. The form of organization is one in which voting is restricted to official chemists, but discussion is open to all chemists. Four meetings prior to 1884 had failed to produce a cohesive and stable organization of both official and commercial chemists. The final organizational form was settled upon with the full cooperation and even insistence of commercial chemists. They agreed on the principle that since it was the official chemists who had the responsibility for the enforcement of the laws, they also had the responsibility for the choice of valid methods of analysis for this purpose.

As the regulatory control of other commodities such as foods, feeds, drugs, cosmetics, caustic poisons, and pesticides became a recognized governmental function, the work of the Association expanded. It has accepted the responsibility of providing the regulatory scientist with accurate and reproducible methods of analysis that are required for the enforcement of

laws and regulations. This is accomplished through adherence to a fundamental constitutional requirement that methods approved by the Association be subjected to collaborative study. In this, a number of representative chemists analyze the same samples by the proposed method to demonstrate its accuracy and reproducibility in their hands. At the present time about 250 chemists, designated as "Associate Referees," are studying methods of analysis grouped in about 50 general categories from "Agricultural Liming Materials" to "Waters." Not all of them are official chemists; many are industry chemists, who because of their specialized knowledge and experience, also participate in the development and testing of methods of analysis. The results of the studies of these Associate Referees form the basis for the actions of the Association in its approval or disapproval of methods.

All State chemists including those of universities and experiment stations are members of the Association. Federal organizations represented in the Association are: Food and Drug Administration, Public Health Service, Department of Agriculture, Department of Defense, Internal Revenue Service, and National Bureau of Standards.

The laws enforced by the AOAC members require objective, scientific evidence for their successful application. The AOAC attempts to provide for both industry and government a common meeting ground for discussion, at a scientific level, of methods of analysis that will be used to obtain this evidence. That this has been successful is indicated by the facts that some State laws specify the use of AOAC methods, where applicable; the Federal Definitions and Standards of Identity for many foods incorporate AOAC methods into their requirements; many Federal specifications and private contracts utilize AOAC methods; and AOAC methods have been quite generally accorded a preferred status in court testimony. Most important of all, the general recognition of AOAC methods removes from the realm of controversy the scientific question of relative validity and merits the available methods of analysis. This is settled by the scientists themselves on the basis of the facts developed during their collaborative studies.

Results of seventy-three years of work by the members of the Association are embodied in its primary publication *Offical Methods of Analysis of the Association of Official Agricultural Chemists*, now in its eighth edition (1955) This publication is a 1000-page laboratory manual which includes 41 chapters, 90 pages of tables, and 45 pages of index. It is an authoritative source of methods of analysis for the regulatory chemist and the agricultural scientist throughout the world. It is supplemented by the quarterly Journal which publishes the transactions of the Association, including the annual changes in methods adopted by the Association, the reports of the Referees, and contributed papers containing new methods, new applications, and authentic or interpretive data.

## RELATIONS BETWEEN THE FOOD AND DRUG ADMINISTRATION AND THE MEAT INSPECTION DIVISION—

1. **Pertinent Legal Provisions—**
   A. The Federal Food, Drug, and Cosmetic Act prohibits interstate shipment of adulterated or misbranded articles, and those otherwise classed as illegal under the act The definition of "food" includes food or drink for animals

as well as man. Meat and meat food products are exempted to the extent that they are covered by the Meat Inspection Act.

*B.* The Federal Meat Inspection Act requires that meat food products moving in interstate commerce be produced in an establishment operating under the continuous inspection of the Department of Agriculture.

*C.* The Federal Food, Drug, and Cosmetic Act (Section 407) defines oleomargarine, requires specific labeling and packaging for colored margarine regardless of source of fat, and (Section 401) authorizes the Secretary of HEW to establish a standard of identity for any food whenever he deems it desirable. A standard has been established for oleomargarine.

2. **Food Processing Practices or Food Products that Affect FDA-MID Relations.—**

*A.* Plants which produce meat products exclusively often utilize some nonmeat food products in the preparation of fabricated meat items (*e.g.*, spices for sausages). The Meat Inspection Division inspects such products to approve or disapprove their use in products which are to bear the "Inspected and Passed" legend of the U. S. Department of Agriculture. The nonmeat items are covered by the Federal Food, Drug, and Cosmetic Act, and a plant which processed an item later rejected by a meat inspector may have been inspected by the Food and Drug Administration. In addition, an imported item (*e.g.*, spices) may have been passed by FDA at a port of entry without actual examination. Imported products do not bear any labeling indicating whether or not they were examined by FDA at time of entry.

*B.* Meat processors (subject to continuous inspection by MID) may also produce other food products which fall under the jurisdiction of FDA.

*C.* In some instances, where meat is only one of a number of items used for a food product, it must be specifically determined which agency has jurisdiction. The proportions of meat which make a product subject to MID inspection varies with the product.

*D.* Some meat processors produce oleomargarine from animal fats. That product is covered by the Federal Meat Inspection Act rather than the Federal Food, Drug, and Cosmetic Act, although certain provisions of the latter act are also applicable.

*E.* The MID approves labels for meat food products, whereas FDA is responsible for labeling of items covered by the Federal Food, Drug, and Cosmetic Act. FDA offers informal comment on labels when requested but, with few specific exceptions, does not have a system of approving labels.

F. Import food products other than meat food products are subject to examination by FDA at the port of entry. Meat food products are subject to examination by MID.

*G.* Horsemeat processing plants are under continuous supervision of the Meat Inspection Division. But denatured horsemeat suitable only for animal food is under the jurisdiction of FDA. Similarly, any instance in which horsemeat produced in an inspected plant was subsequently marketed as beef would be a violation of the Federal Food, Drug, and Cosmetic Act.

*H.* A shipment of meat food products from a plant inspected by MID may become unsatisfactory after it leaves the plant. Such shipments are subject to seizure under the Federal Food, Drug, and Cosmetic Act, since MID jurisdiction extends only to the processing activities, although a procedure is available whereby, in lieu of seizure, the shipment may be returned to the processing plant under permit.

3. **Working processes of FDA and MID** -

*FDA:* Except for a few packers of seafood products, the FDA inspectors make occasional inspections at unannounced intervals of factories, warehouses and other establishments preparing or handling food products. In a few sea-

food packing plants operating under voluntary continuous inspection at the expense of the packer, FDA maintains continuous inspection.

FDA inspectors check on sanitary conditions, the character and condition of raw materials, and manufacturing practices and procedures, including the type of equipment used from the viewpoint of possible contamination. They endeavor to determine whether finished products are properly labeled and whether they comply with applicable standards. Inspectors also collect for examination at FDA laboratories samples of food products not only at the factory but also from interstate shipments. They make investigations concerning the distribution of a product when there is a suspicion that the product may have been the cause of some injury.

*MID:* With few exceptions (farmers, butchers), all meat food products moving in interstate commerce must be produced in an establishment operating under the continuous inspection of the Department of Agriculture. To obtain inspection the structure and facilities of the establishment must be approved by the Department, and then may operate only when inspectors are present. Inspectors see that the plant is maintained in a sanitary condition; that all products are made from clean, wholesome ingredients; that unfit materials such as diseased animals or unfit parts are disposed of as provided in the Department's regulations; and that the finished products are labeled or otherwise properly marked.

4. **Inter-agency working arrangements—**

*A.* In meat food plants which also produce other food products, the MID has jurisdiction over that portion of the establishment handling, preparing, or storing the meat food products. FDA has jurisdiction over that portion of the plant producing nonmeat food products and makes inspections from time to time. Of 1200 plants under the jurisdiction of MID, 47 were inspected by FDA during 1955. Usually the portion of the plant subject to MID inspection is separate from the portion producing nonmeat food items, which are subject to FDA inspection. FDA, in following up on inspection of nonmeat food establishments, may visit meat processing plants to obtain samples of a food product being used as an ingredient of a meat preparation For example, 19 official samples were collected in 1955—raw materials of plants under MID inspection or meat products shipped from those plants.

*B.* If an FDA inspector encounters a condition that might, in his opinion, have some adverse effect on the meat processing operations, he calls the matter to the MID inspector's attention.

*C.* If an MID inspector finds a shipment of a nonmeat food product which he believes is not suitable for use in an inspected meat product, he does not permit the shipment to be used in an inspected plant. If the shipment is rejected because of adulteration, the FDA is notified. Further investigation by FDA often results in seizure of the shipment under the Federal Food, Drug, and Cosmetic Act. In rare instances a product may be rejected by MID as not suitable for use in an inspected product, but FDA may find that it does not have an adequate basis for legal action under the Act. On the other hand, FDA may in some instances institute proceedings against a shipment in the possession of a meat processing plant when the meat inspector had detected nothing wrong with it.

*D* If an FDA inspector encounters a shipment of meat food products which, through improper handling, has become violative after leaving the inspected plant, the situation is discussed with MID personnel. No seizure is made under the Federal Food, Drug, and Cosmetic Act if the MID arranges for the goods to be returned under permit to the processor. In many such instances, MID personnel first discover the unfit shipment and call it to FDA attention FDA may arrange for the official sample to be examined by Meat Inspection veterinarians rather than by the FDA.

*E* The MID requires that margarine produced from animal fats meet the standard of identity for margarine as prescribed by the FDA, and also

that it be labeled as called for in the Federal Food, Drug, and Cosmetic Act, and the standards issued by FDA under the act.

*F.* It is the policy of MID to require that all labels used for meat food products conform to the labeling requirements of the Federal Food, Drug and Cosmetic Act. When in this connection questions arise concerning interpretation of the labeling requirements of the act, MID consults FDA and follows the policies of FDA.

*G.* When FDA has question about the application of the Meat Inspection Act to a meat food product encountered on the market, FDA consults MID and accepts its interpretation. This is particularly pertinent in the area of products which do not contain substantial percentages of meat or meat ingredients.

*H.* Under an informal arrangement, FDA's Division of Pharmacology provides service to MID on toxicological problems involving components of meat food products and equipment being used in meat food establishments, since it is recognized that the ingredients in meat foods and the equipment used in meat food plants are often the same as in other food processing plants.

*I.* In some instances FDA may be guided by MID policies. For example, the MID requires that a "beef pie" contain at least 25 per cent beef. Pending the establishment of a formal standard under the Federal Food, Drug, and Cosmetic Act, the FDA has held that "chicken pie" should contain 25 per cent chicken meat.

*J.* Food processors are quite well aware of the coverage of the Meat Inspection Act and the Federal Food, Drug, and Cosmetic Act, since meat processing can be carried on only when an inspector is present and their formulas and labels must have the approval of MID. If any jurisdictional question arises in a multi-purpose plant, it can be resolved by the meat inspector on the premises.

*K.* Foreign manufacturers sometimes request comment of the FDA on labels for meat food products or similarly from MID on nonmeat products. These are handled by an informal reference system so that the inquirer receives a reply without inconvenience to him.

*L.* FDA may receive a complaint from a consumer about a meat food product, or MID about a nonmeat food item. These are also handled by informal reference to the appropriate agency to avoid inconvenience to the consumer.

The effectiveness of the Federal meat inspection program lies in its use of the authority that is vested in its inspectors to act summarily in an inspected packing plant to destroy diseased or otherwise unfit product, correct an unsanitary condition, prevent adulteration of product, and prevent mislabeling.

After the meat bearing the marks of the inspection is shipped from a federally inspected establishment, it passes out of the direct control of the Meat Inspection Service and into the domain of local and state control and, in the Federal field, the control of the Food and Drug Administration. Each agency acts with a high degree of autonomy in its particular jurisdiction but there is a close working relationship between the various groups that have meat control responsibility.

The following quotation from a memorandum by Dr. L. D. Elliott, Acting Commissioner of Food and Drugs, Food and Drug Administration, is not only a good example or cooperative relations between that Administration and the Federal Meat Inspection Service but also serves to illustrate how the activities of the two agencies are coordinated.

"Section 902(b) of our law (The Food, Drug and Cosmetic Act of 1938)

exempts meats and meat-food products from its provisions to the extent of the application of the Meat Inspection Act. Since the Meat Inspection Act contains no seizure provisions (outside inspected establishments), meats and meat-food products which are violative of our Act are therefore not exempt from seizure under our law. The Meat Inspection Service has in the past and will continue to welcome seizure actions by us against violative meat-food products found in interstate channels in the interest of the protection of the public in view of their own inability to take such action (outside inspected establishments). If a Federal meat inspector, or other representative of that agency stationed anywhere in the field, encounters a consignment of a meat product which he finds to be or has reason to suspect of being unsound and unwholesome, he has no authority under his law to institute action against it but he has the responsibility of calling the consignment to the attention of the nearest available regulatory food official who does have the authority to seize it or to put some restraining order on it to prevent its distribution to the consuming public. If the inspector is located in one of our station cities or where one of our inspectors may be nearby, he calls it to the attention of our station or inspector, and in so doing he is saying in effect that the Meat Inspection Service is turning the consignment over to the Food and Drug Administration for whatever action it deems appropriate under its seizure provisions. If the Federal meat inspector happens to be located at a place remote from any of our people but near a state official, he would call the attention of the state official to a violative consignment for whatever action the state official might desire to take under his law.

"If an obviously violative interstate shipment of meat-food product is located or detected by our own people rather than by a Federal meat inspector, the Meat Inspection Service has no objection to our proceeding with action under our law, but expects us to notify the nearest Federal meat inspection office of the facts not only as a matter of maintaining proper cooperative contact, but to enable the Meat Inspection Service to institute a prompt investigation at the establishment where the consignment originated to locate and correct conditions that might be responsible for the deterioration of the product.

"Sometimes the consignee of a shipment, upon suspecting it of being unsound or otherwise unfit for food, desires to ship it back to the inspected establishment where it originated. However, the Meat Inspection Act, according to my understanding, makes both the shipper and the carrier amenable to the penal provisions for the interstate shipment of an unsound meat-food product. Therefore, to take care of the situation where a consignee desires to ship the suspected consignment back to the establishment where the Meat Inspection Service can reassume jurisdiction, the Meat Inspection Service is authorized to issue a permit to the reshipper and carrier, which in effect exempts them from the penal provisions of the Act on that particular reshipment. The issuance of such a permit is not to be interpreted as a desire on the part of the Meat Inspection Service that the Food and Drug Administration refrain from seizure of the goods in the hands of the consignee. As a matter of fact, since the Meat Inspection Service has no jurisdiction over the goods shipped under such permit

until they reach the inspected establishment, there is nothing to prevent the diversion of the consignment en route.

"The Meat Inspection Service is perfectly willing for us to proceed with any contemplated seizure so that if the goods are subsequently taken down under bond for reshipment to the inspected establishment for segregation and destruction of the unfit material, there will be the additional safeguard of a bond."

**Federal Food and Drug Administration.**—To discharge its technical, administrative, and regulatory responsibilities, the personnel of the Food and Drug Administration includes chemists, bacteriologists, physicians, veterinarians, microscopists, pharmacologists, inspectors, administrative officers, and other specialists. These are divided into a field service organized into 16 districts and staffed by more than 600 people, and the central administrative office in Washington, D. C., where there are also extensive laboratory facilities.

The district headquarters are manned by inspectors and analysts working under the direction of a district chief. This organization is sufficiently flexible to permit shifting its personnel from routine law enforcement to a mobilized effort which is necessary from time to time to cope with emergencies. Such a shift may become necessary because of the contamination and spoilage of large quantities of foods by flood waters or in connection with the discovery that a dangerous food has become widely distributed. Each district is responsible to see that the laws enforced by the Food and Drug Administration are complied with by the manufacturers, dealers, and importers who trade within the specified territory making up the district.

The Food Division is one of several subject matter divisions in the Administration's central office and it is the leader in the development of scientific methods of food law enforcement. It is the repository of existing technical knowledge and a workshop for improving and developing methods of analysis for establishing definite proof of violations. The Division acts as a reviewing laboratory in cases developed under the food provisions of the several acts enforced by the Administration and furnishes expert witnesses for court cases. It prepares project plans on foods and initiates and executes the investigational work which is an essential preliminary to regulatory activity. In such investigations the Food Division, with the assistance of the field force, ascertains current trade practices through the medium of factory inspections; prepares and subsequently analyzes experimental packs of food products; determines the composition of numerous market samples; and acquires information concerning consumer understanding of the composition of foods and various trade practices.

To promote honesty and fair dealing in the interest of consumers, authority is granted by the Food, Drug and Cosmetic Act for the formulation and issuance of regulations establishing for any food a reasonable definition and standard of (1) identity, (2) quality, and (3) fill of container. Special investigations are conducted by the Food Division in connection with the formulation of such food standards.

**Cooperation with State and Local Officials.**—For the purpose of developing and maintaining active cooperation with all State and local officials en-

forcing State and local food and drug laws, there is a Division of State Cooperation. Through the program of mutual assistance sponsored by this Division it is possible for State and Federal officials to check adulteration and misbranding within their respective jurisdictions more effectively. There is extensive interchange of information among all regulatory officials. Data for the solution of technical and administrative problems are made available upon request. Frequent area conferences, continuous contact between field forces of the Food and Drug Administration and State and local officials, and national and sectional associations of regulatory personnel also stimulate cooperation. Responsible State officials are commissioned by the Federal agency to conduct examinations and investigations as its agents in the enforcement of the Federal Food, Drug and Cosmetic Act.

Since enforcement of the Food, Drug and Cosmetic Act with complete coverage is impossible, selective enforcement is necessary. Furthermore, from the consumer viewpoint, not all types of violations are of equal importance. Coupled with this segregation of types of violations is a segregation of products and manufacturers most commonly found to violate the law. This is done by obtaining as nearly complete knowledge as possible of the practices of every branch of the food industry. By this means the detection of probable violations and the identification of those manufacturers whose operations are apt to require supervision are possible.

Experience has demonstrated that in the case of certain products adulteration or misbranding is practically never found. The Administration is thus enabled to concentrate its working forces and its funds largely upon those products usually in violation of the law. Once violations of the law are encountered, simultaneous and uniform action against them is instituted throughout the country by the various food and drug districts. This plan of regulatory action based upon the application of these principles of planning to apply controls to a group of related products is termed a project plan.

**Methods of Enforcement.**—In appropriate instances the institution of formal legal action may be preceded by a public hearing at which interested persons may participate in the determination of an administrative policy. In line with the emphasis upon educational effort as part of the program of enforcement, the Act allows resort to a suitable written notice of warning when it is thought to be warranted by the public interest as an alternative to punitive action to control minor violations. Apart from this, the Food and Drug Administration is constantly informing the industries subject to the Act of its requirements with a view to keeping actual violations at a minimum. This is done by means of correspondence and various types of publicity releases informing manufacturers and shippers of the legal requirements imposed upon them. In addition to advisory legal interpretations, such information may also take the form of valuable technical data, the utilization of which by those affected will permit a ready compliance with the Act.

In addition to informal methods of enforcement, the Food and Drug Administration has its choice of several formal legal actions. One of these is actual seizure of the offending products, known legally as a libel for condemnation proceeding. In such a proceeding the articles in question

are seized to prevent them from reaching the ultimate consumer. The seizure follows the request by the Food and Drug Administration of a United States Attorney that he file a libel (a descriptive legal document) with the proper Federal Court. Acting upon a court warrant issued pursuant to the filing of a libel, a United States marshal (usually accompanied by a Food and Drug Administration inspector) seizes the articles. They are then within the jurisdiction of the court. The party who has an interest in the seized articles, known technically as the claimant, may fail to make an appearance before the court, in which event the case is disposed of on default. Or he may appear but agree with the contentions of the Administration in the libel, in which event a consent decree would issue. When the claimant contests the seizure, the question of whether or not the articles are in violation of the Act is tried in Federal Court.

Products which have been seized and condemned are not necessarily destroyed, but they may not be disposed of contrary to the provisions of the Food, Drug and Cosmetic Act or the laws of any State or territory in which the disposition happens to take place. The court may order the offending products destroyed if they cannot be reclaimed in any way, which is true of decomposed foods and foods containing poisonous substances. But frequently adequate reworking (by which there can be affected the removal of excess moisture from butter), sorting, (often possible with canned goods not all of which have been damaged), or cleaning (appropriate for the separation of excessive débris from nuts), will correct the adulteration. In the same way, relabeling (for such violations as an incorrect statement of net weight) will often render misbranded articles entirely legal and suitable for distribution. Under these circumstances the articles may be released to their owner under bond for reconditioning under governmental supervision.

When an adverse decision against the claimant has been rendered, or when the owner has abandoned goods which have been seized, the court, as alternatives to destruction, may either give them outright to charity, or direct their sale by the appropriate United States marshal after ordering him first to eliminate the adulteration or misbranding involved. The proceeds of the sale, less the legal costs incurred, are sent to the United States Treasury.

A second penalty is criminal prosecution of the person or firm responsible for the violations of the provisions of the Act. For the commission of any of the deeds prohibited by law, a maximum fine of $1,000 and imprisonment not in excess of one year may be imposed. Where the violation is done with intent to defraud or mislead, or where it is a second offense, the maximum fine becomes $10,000 and maximum imprisonment three years.

The third method of enforcement is through the use of the injunction. In some instances, seizure and criminal prosecution are unsatisfactory means of enforcement especially where a person or firm indulges in repeated and frequent violations. Congress has therefore authorized the Administration to apply to Federal District Courts for restraining orders (injunctions) which, in effect, deny the channels of interstate commerce to adulterated or misbranded foods.

**Selection of Appropriate Penalty.**—Each of the above penalties is sought by the Food and Drug Administration under well-defined circumstances. Seizure is employed against products containing ingredients harmful to health and those marred by filth and decomposition. Seizure is used also to prevent the distribution of products containing grossly false or misleading claims and those adulterated or misbranded so as to seriously demoralize legitimate trade practices. The Food, Drug and Cosmetic Act permits more than one libel proceeding to be instituted simultaneously—so-called multiple seizure—when the evidence indicates probable cause that the misbranding is fraudulent, or dangerous to the health, or in a material respect misleading, to the injury or damage of the consumer. The object of both single and multiple seizures is to prevent adulterated or misbranded products from reaching and harming the ultimate consumer. This is achieved by removing the offending articles from the market. Consequently, seizures occur wherever the consignment happens to be found.

Criminal prosecution is directed against the person or firm responsible for the offense and is always confined to the jurisdiction where the defendant has his place of business. It is necessarily a slower remedy because the Act requires that a potential defendant be first given appropriate notice and an opportunity to present his oral or written views on the matter, after which proper pleadings must be drawn up, affidavits of analyst and other witnesses secured, and all forwarded through the Department of Justice to the United States Attorney in whose jurisdiction the defendant has his business. The case must then await its turn on the calendar. The trial itself is subject to the legal restrictions necessarily prevailing in criminal procedure, an important one of which requires exacting evidence to prove guilt. The result is that though criminal prosecution may legally be based upon the same consignment which led to the institution of seizure proceedings, such prosecution is often precluded where seizure action can be maintained. This is true, for example, of perishable foods that are subject to seizure because decomposition occurred after shipment. In

# APPENDIX

| | *Beef* | | *Veal* | | *Lamb & Mutton* | | *Pork* | | *All Meats* | |
|---|---|---|---|---|---|---|---|---|---|---|
| | *Production* | *Per Cap.* | *Production* | *Per Cap.* | *Production* | *Per Cap.* | *Production* | *Per Cap.* | *Production* | *Per Cap.* |
| | *Mil.Lb.* | *Lb.* | *Mil Lb.* | *Lb.* | *Mil.Lb.* | *Lb.* | *Mil.Lb.* | *Lb.* | *Mil.Lb.* | *Lb.* |
| 1900 | 5,628 | 67.1 | 397 | 5.2 | 493 | 6.5 | 6,329 | 71.9 | 12,847 | 150.7 |
| 1905 | 6,504 | 71.3 | 556 | 6.6 | 530 | 6.3 | 6,629 | 71.0 | 14,219 | 155.2 |
| 1906 | 6,537 | 71.3 | 598 | 7.0 | 543 | 6.3 | 6,793 | 71.0 | 14,471 | 155.6 |
| 1907 | 6,544 | 70.6 | 626 | 7.2 | 553 | 6.3 | 7,059 | 74.1 | 14,782 | 158.2 |
| 1908 | 6,662 | 72.1 | 637 | 7.2 | 559 | 6.3 | 7,535 | 77.7 | 15,393 | 163.3 |
| 1909 | 6,915 | 73.5 | 660 | 7.2 | 608 | 6.7 | 6,557 | 66.4 | 14,740 | 153.8 |
| 1910 | 6,647 | 69.8 | 667 | 7.1 | 597 | 6.4 | 6,087 | 61.8 | 13,998 | 145.1 |
| 1911 | 6,549 | 67.9 | 666 | 7.0 | 693 | 7.3 | 6,961 | 68.4 | 14,869 | 150.6 |
| 1912 | 6,234 | 64.0 | 662 | 6.9 | 735 | 7.6 | 6,822 | 66.2 | 14,453 | 144.7 |
| 1913 | 6,182 | 62.8 | 608 | 6.2 | 706 | 7.2 | 6,979 | 66.3 | 14,475 | 142.5 |
| 1914 | 6,017 | 61.5 | 569 | 5.7 | 693 | 7.1 | 6,824 | 64.5 | 14,103 | 138.9 |
| 1915 | 6,075 | 56.0 | 590 | 5.8 | 605 | 6.0 | 7,016 | 66.1 | 14,886 | 133.9 |
| 1916 | 6,460 | 58.4 | 655 | 6.4 | 585 | 5.8 | 8,207 | 68.4 | 15,907 | 139.0 |
| 1917 | 7,239 | 64.2 | 744 | 7.1 | 463 | 4.4 | 7,055 | 58.5 | 15,501 | 134.2 |
| 1918 | 7,726 | 68.0 | 760 | 7.2 | 506 | 4.7 | 8,349 | 60.6 | 17,341 | 140.5 |
| 1919 | 6,756 | 61.0 | 819 | 7.8 | 590 | 5.6 | 8,477 | 63.4 | 16,642 | 137.8 |
| 1920 | 6,306 | 58.6 | 842 | 7.9 | 538 | 5.4 | 7,648 | 63.1 | 15,334 | 135.0 |
| 1921 | 6,022 | 55.1 | 820 | 7.5 | 639 | 6.1 | 7,697 | 64.3 | 15,178 | 133.0 |
| 1922 | 6,588 | 58.6 | 852 | 7.7 | 553 | 5.1 | 8,145 | 65.3 | 16,138 | 136.7 |
| 1923 | 6,721 | 59.2 | 916 | 8.1 | 588 | 5.3 | 9,483 | 73.7 | 17,708 | 146.3 |
| 1924 | 6,877 | 59.1 | 972 | 8.5 | 597 | 5.2 | 9,149 | 73.5 | 17,595 | 146.3 |
| 1925 | 6,878 | 59.1 | 989 | 8.5 | 603 | 5.2 | 8,128 | 66.3 | 16,598 | 139.1 |
| 1926 | 7,089 | 59.8 | 955 | 8.1 | 639 | 5.4 | 7,966 | 63.7 | 16,649 | 137.0 |
| 1927 | 6,395 | 51.1 | 867 | 7.3 | 629 | 5.3 | 8,430 | 67.3 | 16,321 | 131.0 |
| 1928 | 5,771 | 48.4 | 773 | 6.4 | 663 | 5.5 | 9,011 | 70.5 | 16,218 | 130.8 |
| 1929 | 5,871 | 49.3 | 761 | 6.3 | 682 | 5.6 | 8,833 | 69.2 | 16,147 | 130.4 |
| 1930 | 5,917 | 48.6 | 792 | 6.4 | 825 | 6.7 | 8,482 | 66.6 | 16,016 | 128.3 |
| 1931 | 6,009 | 48.3 | 823 | 6.6 | 885 | 7.1 | 8,739 | 67.9 | 16,456 | 129.9 |
| 1932 | 5,789 | 46.4 | 822 | 6.5 | 884 | 7.0 | 8,923 | 70.3 | 16,418 | 130.2 |
| 1933 | 6,440 | 51.2 | 894 | 7.1 | 852 | 6.7 | 9,231 | 70.3 | 17,417 | 135.3 |
| 1934 | 8,345 | 63.5 | 1,216 | 9.3 | 851 | 6.3 | 8,397 | 64.0 | 18,839 | 143.1 |
| 1935 | 6,608 | 52.0 | 1,023 | 8.5 | 877 | 7.2 | 5,619 | 48.1 | 14,127 | 116.7 |
| 1936 | 7,358 | 60.1 | 1,075 | 8.3 | 851 | 6.6 | 7,474 | 51.8 | 16,761 | 129.8 |
| 1937 | 6,798 | 51.8 | 1,108 | 8.6 | 852 | 6.6 | 6,951 | 55.4 | 15,709 | 125.4 |
| 1938 | 6,908 | 51.0 | 991 | 7.6 | 897 | 6.8 | 7,680 | 57.8 | 16,479 | 126.2 |
| 1939 | 7,011 | 51.4 | 991 | 7.5 | 872 | 6.6 | 8,660 | 64.3 | 17,534 | 132.8 |
| 1940 | 7,175 | 51.7 | 981 | 7.4 | 876 | 6.6 | 10,044 | 73.0 | 19,076 | 141.7 |
| 1941 | 8,082 | 60.5 | 1,036 | 7.6 | 923 | 6.8 | 9,528 | 67.9 | 19,569 | 142.8 |
| 1942 | 8,843 | 60.3 | 1,151 | 8.2 | 1,042 | 7.2 | 10,876 | 63.3 | 21,912 | 139.5 |
| 1943 | 8,571 | 52.9 | 1,167 | 8.2 | 1,104 | 6.4 | 13,640 | 78.5 | 24,482 | 146.0 |
| 1944 | 9,112 | 55.3 | 1,728 | 12.1 | 1,024 | 6.6 | 13,304 | 79.2 | 25,178 | 153.5 |
| 1945 | 10,275 | 59.0 | 1,661 | 11.8 | 1,054 | 7.3 | 10,697 | 66.3 | 23,687 | 144.1 |
| 1946 | 9,373 | 61.3 | 1,440 | 9.9 | 970 | 6.6 | 11,173 | 75.6 | 22,956 | 153.4 |
| 1947 | 10,128 | 69.1 | 1,599 | 10.7 | 802 | 5.4 | 10,601 | 69.8 | 23,130 | 155.0 |
| 1948 | 9,079 | 62.6 | 1,112 | 9.4 | 750 | 5.0 | 10,205 | 68.4 | 21,146 | 145.4 |
| 1949 | 9,438 | 63.5 | 1,332 | 8.7 | 607 | 4.1 | 10,333 | 67.6 | 21,710 | 143.9 |
| 1950 | 9,538 | 63.0 | 1,230 | 8.0 | 597 | 3.9 | 10,714 | 68.6 | 22,079 | 143.5 |
| 1951 | 8,843 | 55.2 | 1,061 | 6.6 | 521 | 3.4 | 11,483 | 70.6 | 21,908 | 135.8 |
| 1952 | 9,667 | 61.2 | 1,173 | 7.4 | 648 | 4.1 | 11,547 | 71.6 | 23,035 | 144.1 |
| 1953 | 12,444 | 76.6 | 1,559 | 9.5 | 729 | 4.6 | 10,063 | 62.9 | 24,795 | 153.6 |
| 1954 | 12,991 | 79.2 | 1,661 | 10.0 | 735 | 4.5 | 10,010 | 60.0 | 25,403 | 153.7 |

Compiled by the American Meat Institute

Fig. 128 – Meat Production and Per Capita Consumption in U.S. Including Farm Production

| Muscle Cuts Medium Grade | Protein % | Water % | Fat % | Ash % | Calcium mg/100g | Phosphorus mg/100g | Iron mg/100g | Sodium mg/100g | Potassium mg/100g | Calories/100g 100g |
|---|---|---|---|---|---|---|---|---|---|---|
| *Beef* | | | | | | | | | | |
| Chuck | 18.6 | 65 | 16 | 0.9 | 11 | 167 | 2.8 | | | 221 |
| Flank | 19.0 | 61 | 18 | 0.9 | 12 | 180 | 3.0 | | | 217 |
| Loin | 19.7 | 57 | 25 | 0.8 | 10 | 182 | 2.5 | | | 203 |
| Rib | 17.4 | 59 | 23 | 0.8 | 10 | 119 | 2.6 | 11 | 310 | 282 |
| Round | 19.5 | 69 | 11 | 1.0 | 11 | 180 | 2.0 | | | 182 |
| Rump | 19.2 | 55 | 28 | 0.8 | 9 | 131 | 2.1 | | | 322 |
| *Veal* | | | | | | | | | | |
| Cutlet | 19.0 | 70 | 5 | 1.3 | 6 | 313 | 10.6 | | | 141 |
| Leg | 19.1 | 68 | 12 | 1.0 | 11 | 200 | 2.9 | | | 180 |
| Shoulder | 19.1 | 70 | 10 | 1.0 | 11 | 199 | 2.9 | | | 173 |
| *Pork* | | | | | | | | | | |
| Ham | 15.2 | 53 | 31 | 0.8 | 9 | 168 | 2.3 | | | 311 |
| Loin | 16.4 | 58 | 25 | 0.9 | 10 | 186 | 2.5 | | | 296 |
| Shoulder | 13.5 | 49 | 37 | 0.7 | | | | | | 387 |
| Spareribs | 14.6 | 51 | 32 | 0.8 | 8 | 157 | 2.2 | | | 316 |
| *Lamb* | | | | | | | | | | |
| Breast | 12.8 | 48 | 37 | | | | | | | 381 |
| Leg | 18.0 | 64 | 18 | 0.9 | 10 | 213 | 2.7 | 78 | 380 | 235 |
| Loin | 18.6 | 65 | 16 | | | | | | | 217 |
| Rib chop | 14.9 | 52 | 32 | 0.8 | 9 | 138 | 2.2 | 98 | 310 | 350 |
| Shoulder | 15.6 | 58 | 25 | 0.8 | 9 | 155 | 2.3 | | | 295 |

(Compiled by the American Meat Institute Foundation.)

FIG. 129.—Proximate Composition, Mineral and Caloric Content of Fresh Muscle Cuts.

| Organ Meats | Protein % | Water % | Fat % | Ash % | Calcium mg/100g | Phosphorus mg/100g | Iron mg/100g | Sodium mg/100g | Potassium mg/100g | Calories/100g |
|---|---|---|---|---|---|---|---|---|---|---|
| *Beef* | | | | | | | | | | |
| Brain | 10.5 | 78 | 9 | 1.4 | 8 | 380 | 2.3 | | | 127 |
| Heart | 16.9 | 78 | 1 | 1.1 | 9 | 203 | 4.6 | 90 | 160 | 108 |
| Kidney | 15.0 | 75 | 8 | 1.1 | 9 | 221 | 7.9 | 210 | 310 | 141 |
| Liver | 19.7 | 70 | 3 | 1.4 | 7 | 358 | 6.6 | | | 136 |
| Lung | 18.3 | 79 | 2 | 1.0 | | | | | | 89 |
| Pancreas | 13.5 | 60 | 25 | 1.2 | | | | | | 279 |
| Spleen | 18.1 | 77 | 3 | 1.4 | | | 8.9 | | | 99 |
| Thymus | 11.8 | 51 | 33 | 1.1 | 14 | 596 | 1.6 | 96 | 360 | 344 |
| Tongue | 16.4 | 68 | 15 | 0.9 | 9 | 187 | 2.8 | 100 | 260 | 207 |
| Calf liver | 19.0 | 71 | 5 | 1.3 | 6 | 343 | 10.6 | 110 | 380 | 141 |
| Calf pancreas | 19.2 | 70 | 9 | 1.4 | | | | | | 156 |
| Calf thymus | 19.6 | 75 | 3 | 1.9 | | | | | | 106 |
| *Pork* | | | | | | | | | | |
| Brain | 10.6 | 78 | 9 | 1.5 | | | | 150 | 340 | 126 |
| Heart | 16.9 | 77 | 5 | 1.1 | 35 | 132 | 2.7 | | | 117 |
| Kidney | 16.3 | 77 | 5 | 1.2 | 11 | 216 | 8.0 | | | 114 |
| Liver | 19.7 | 72 | 5 | 1.5 | 10 | 362 | 18.0 | 77 | 350 | 134 |
| Lung | 12.9 | 84 | 2 | 0.8 | | | | | | 71 |
| Pancreas | 11.5 | 60 | 24 | 1.1 | | | | 57 | 210 | 272 |
| Spleen | 17.1 | 77 | 4 | 1.4 | | | | | | 103 |
| Tongue | 16.8 | 66 | 16 | 1.0 | | | | | | 210 |
| *Lamb* | | | | | | | | | | |
| Brain | 11.8 | 79 | 8 | 1.4 | | | | | | 121 |
| Heart | 10.8 | 72 | 10 | 1.0 | | | | | | 158 |
| Kidney | 10.6 | 78 | 3 | 1.3 | 13 | 237 | 9.2 | | | 105 |
| Liver | 21.0 | 71 | 4 | 1.4 | 8 | 361 | 12.6 | | | 136 |
| Lung | 17.9 | 79 | 2 | 1.1 | | | | | | 85 |
| Spleen | 18.8 | 74 | 4 | 1.6 | | | | | | 110 |
| Thymus | 11.1 | 80 | 4 | 1.3 | | | | | | 91 |
| Tongue | 13.9 | 70 | 15 | 0.8 | | | | | | 189 |

(Compiled by the American Meat Institute Foundation.)

FIG. 130.—Proximate Composition, Mineral and Caloric Content of Fresh Organ Meats

# STANDARD METHODS FOR THE EXAMINATION OF WATER AND SEWAGE

Prepared, Approved, and Published Jointly by the American Public Health Association and the American Water Works Association

## SAMPLES

### A. Collection

Samples for bacterial analysis shall be collected in bottles which have been cleansed with great care, rinsed in clean water, and sterilized.

Great care must be exercised to have the samples representative of the water to be tested and to see that no contamination occurs at the time of filling the bottles or prior to examination. Ample air spaces should be left between the stopper and the level of the water sample in the bottle in order to facilitate mixing of the sample by shaking, preparatory to examination.

### B. Storage and Transportation

Because of the rapid and often extensive changes which may take place in the bacterial flora of bottled samples when stored even at temperatures as low as 10° C., it is urged, as a matter of importance, that all samples be examined as promptly as possible after collection.

The time allowed for storage or transportation of a bacterial sample between the filling of the sample bottle and the beginning of the analysis should not be more than six hours for impure waters and not more than twelve hours for relatively pure waters. During the period of storage, the temperature shall be kept between 6° and 10° C. Any deviation from the above limits shall be so stated in making reports.

## DILUTIONS

Dilution bottles shall be sterilized in the autoclave at 15 pounds (121° C.) for fifteen minutes after the pressure reaches 15 pounds.

Dilution bottles or tubes shall be filled with the proper amount of water so that after sterilization they shall contain 9 or 99 ml., as desired, with a tolerance of 2 per cent. The exact amount of water to be placed in the bottles may be determined only by experiment with the particular autoclave in use. If desired, the 9 ml dilution may be measured from a flask of sterile water with a sterile pipette.

The water used for dilution shall be tap water. Distilled water shall not be used.

The sample bottle shall be shaken vigorously 25 times and 1 ml. withdrawn and added to the proper dilution bottle or tube as required. Each dilution bottle or tube after the addition of the 1 ml. of the sample shall be shaken vigorously 25 times before a second dilution is made from it, or before a portion is removed.

## PLATING

Plating shall be completed within twenty minutes after dilutions are made. One-half ml or 1 ml. of the sample or dilution shall be used for plating and shall be placed in the Petri dish first. Ten ml. of liquefied medium (nutrient agar, tryptone glucose extract agar, or gelatin) at a temperature of about 42° C. shall be added to the water in the Petri dish.

The cover of the Petri dish shall be lifted just enough for the introduction of either the pipette or culture medium and the lips of all test tubes or flasks used for pouring the medium shall be flamed. The medium and sample in the Petri dish shall be thoroughly mixed and uniformly spread over the bottom of the Petri dish by tilting and rotating the dish. All plates shall be solidified as rapidly as possible after pouring and placed immediately in the appropriate incubator.

## INCUBATION

Gelatin plates shall be incubated for 48 ± 3 hours at 19° to 21° C. in a dark, well-ventilated incubator in an atmosphere practically saturated with moisture.

Agar plates may be used for counts made either at 19° to 21° C. or 35° to 37° C. The time for incubation at the lower temperature shall be 48 ± 3 hours and that at the higher temperature, 24 ± 2 hours. The incubators shall be dark, well ventilated and the atmosphere shall be practically saturated with moisture. Glass covered plates shall be inverted in the incubator. Any deviation from the above described method shall be stated in making reports. Plates shall not be closely packed.

When reporting the results of water examination the medium used for the total count should be stated, *i. e.*, whether gelatin or agar, and the temperature of incubation given.

## COUNTING

In preparing plates such amounts of the water under examination shall be planted as will give from 30 to 300 colonies on a plate and the aim should be always to have at least two plates giving colonies between these limits.

Where it is possible to obtain plates showing density of colonies within these limits, only such plates should be considered in recording results, except when the same amount of water has been planted in two or more plates, of which one gives colonies within these limits, while others give less than 30 or more than 300. In such case, the result recorded should be the average of all the plates planted with this amount of water.

Ordinarily, it is not desirable to plant more than 1 ml. of water in a plate; therefore, when the total number of colonies developing from 1 ml. is less than 30, it is obviously necessary to record the result as observed, disregarding the general rule given above.

Counting shall be done with a lens giving a magnification of 1½ diameters. An approved counting aid, known as the Quebec Colony Counter is recommended. In order to insure uniformity of counting conditions, illumination equivalent to that provided by the Quebec Colony Counter shall be employed.

In order to avoid fictitious accuracy and yet express the numerical results by a method consistent with the precision of the technique employed, the recorded number of bacteria per ml. shall include not more than two significant figures. For example, a count of 142 is recorded as 140, and a count of 145 is recorded as 150; whereas a count of 35 is recorded as such.

The gelatin count at 19° to 21° C. and the agar counts at 19° to 21° C. and at 35° to 37° C. shall be designated "standard gelatin plate count," "20° C. standard agar plate count," and "37° C. standard agar plate count," respectively.

## TESTS FOR THE PRESENCE OF MEMBERS OF THE COLIFORM GROUP

### A. Introduction and Definitions

#### *1. Definition*

It is recommended that the coliform group be considered to include all aerobic and facultative anaerobic Gram-negative non-spore-forming bacilli which ferment lactose with gas formation.

The "coliform group" as defined above is equivalent to the "B. coli group" as used in all editions of Standard Methods for the Examination of Water and Sewage prior to the sixth edition, and to the "coli-aerogenes group" of later editions.

### 2. The Standard Tests

The standard tests for the coliform group shall be either the Presumptive Test, or the Confirmed Test.

In these standard tests lauryl sulfate tryptose broth may be substituted for lactose broth in the examination of all water except final filtered, treated, and filtered-treated waters. It may be substituted for lactose broth also in the examination of final filtered, treated and filtered-treated waters provided the laboratory worker has amply demonstrated by correlation of positive *completed tests* (isolations of coliform organisms) secured through the use of lauryl sulfate tryptose broth with those secured through the use of lactose broth, in the examination of such waters, that the substitution results in no reduction from the density of coliform organisms indicated by the standard procedure using lactose broth.

### 3. Presumptive Test

The formation of gas in a standard lactose broth fermentation tube at any time within 24 ± 2 hours with incubation at 35° to 37° C. is presumptive evidence of the presence of coliform organisms, since the majority of the bacilli which give such a reaction belong to the group.

### 4. Confirmed Test

The formation of gas at any time within 48 ± 3 hours with incubation at 35° to 37° C. in a fermentation tube containing brilliant green lactose bile broth which has been seeded from a lactose broth fermentation tube in which gas has formed, or the appearance of aerobic lactose-splitting, typical Escherichia coli colonies on a specified solid confirmatory medium streaked from a lactose fermentation tube in which gas has formed, confirms the presumption that gas formation in the fermentation tube was due to the presence of members of the coliform group. (If only colonies not typical of Escherichia coli have developed on the solid medium, the Completed Test is to be applied.)

### 5. Completed Test

To complete the demonstration of the presence of organisms of this group, it is necessary to show that one or more aerobic plate colonies consist of Gram-negative non-spore-forming bacilli, which, when inoculated into a lactose broth fermentation tube, form gas.

### 6. Reporting Results

In reporting results, the particular test (Presumptive, Confirmed or Completed) applied to the sample should be recorded.

### 7. Differentiation

When it is desired to differentiate between the various sections of the coliform group, the detailed procedure shall not follow primary planting in liquid media, but shall be based upon primary planting of the sample in solid media.

## B. Presumptive Test

### 1. Procedure

Inoculate a series of lactose broth fermentation tubes with appropriate graduated quantities of the water to be tested.

Comparatively large volumes (*e. g.*, 100 ml.) of sample, intended for detection of the presence of coliform organisms, may be planted directly into lactose broth at the site of collection of the sample, *using ordinary dilution bottles, 6 or 8 ounce* bottles, containing multiple-strength lactose broth and equipped with inverted

vial or Cowles tube. Such bottles may be marked with graduations to eliminate the necessity of using pipettes for transfer of medium and sample.

Incubate the fermentation tubes at 35° to 37° C. for 48 ± 3 hours unless gas appears earlier. Examine each tube at the end of 24 ± 2 hours and if no gas has formed, again at the end of 38 ± 3 hours. Record presence or absence of gas formation at each examination of the tubes.

More detailed records of the amount of gas formed, though desirable for the purpose of study, are not necessary for performing the standard tests prescribed.

Formation with 24 ± 2 hours of gas in the inverted vial in the fermentation tube constitutes a Positive Presumptive Test.

If no gas is formed in 24 ± 2 hours, the incubation shall be continued to 48 ± 3 hours. If gas in any quantity is present at the end of the second but not the first twenty-four hours incubation period, the test is considered as doubtful and the presence of organisms of the coliform group should be confirmed by means of the procedure described in "C" or "D," which follow.

The absence of gas formation at the end of 48 ± 3 hours' incubation constitutes a negative test. (An arbitrary limit of forty-eight hours' observation doubtless excludes from consideration occasional members of the coliform group which form gas very slowly, but for the purpose of a standard test the exclusion of these occasional slow gas-forming organisms is considered immaterial.)

### C. Confirmed Test

The use of Endo or eosin methylene-blue plates, or of the liquid confirmatory brilliant-green lactose bile is permitted.

Crystal violet broth may be used as an alternate medium where its use has been shown to yield a maximum number of coliform organisms as indicated by a series of completed tests.

It is desirable that all lactose broth tubes showing gas at the end of twenty-four hours and those showing gas only at the end of 48 hours' incubation be submitted to this test. In routine work, however, it is permissible to submit to the Confirmed Test all the lactose broth tubes showing gas, of those containing the two highest dilutions (dilutions containing the smallest portions) of sample that have produced gas.

Thus, if only one or two dilutions of sample have been planted in lactose broth tubes, all tubes showing gas shall be confirmed, but if three or more dilutions of samples have been planted, only the tubes showing gas from the two highest gas-producing dilutions of sample need be submitted to the Confirmed Test.

For example, if 5 tubes of each of three dilutions are planted, and if gas appears in all tubes, the 5 tubes of the highest dilution and the 5 tubes of the middle dilution should all be confirmed. Again, if gas appears in only 1 of the 5 tubes of the highest dilution, three of the middle dilution, and four of the lowest dilution, only the 1 tube of the highest and the 3 tubes of the middle dilution showing gas need be confirmed.

In such cases all remaining lactose broth tubes showing gas that have not been submitted to the Confirmed Test shall be recorded as containing coliform organisms, even though all the Confirmed Tests made yield negative results.

Transfers from the lactose broth tubes to plates or to confirmatory liquid media should be made as soon as gas appears. In routine work, however, it is permissible to make observations and transfers at 24 ± 2 hours and 48 ± 3 hours of incubation.

#### *1. Procedure*

1.1. Endo or eosin methylene-blue plates. Streak one or more plates from each of the selected tubes showing gas formation in lactose broth; it is essential that the plates be so streaked as to insure the presence of some discrete colonies, separated by at least 0.5 cm. from one another.

1.1.1. Incubate the plates at 35° to 37° C. for 24 ± 2 hours.

1.1.2. Results, typical (Escherichia coli) or atypical.

If typical Escherichia coli colonies have developed on the plate within the incubation period of 24 ± 2 hours, the result of the confirmed test may be considered positive.

If only atypical colonies have developed within 24 ± 2 hours, the result cannot yet be considered definitely negative, since many coliform organisms fail to form typical colonies on Endo or eosin methylene-blue plates, or the colonies develop slowly. *In such case, it is always necessary to complete the test as directed under "D," below.*

1.2. Brilliant-green lactose bile broth. Transfer from the lactose broth tube showing gas to a fermentation tube containing brilliant-green lactose bile broth.

When making transfers from the lactose broth tube showing gas, the tube shall first be gently shaken, or mixed by rotating, and the transfer shall be made by means of a wire loop not less than 3 mm. in diameter.

1.2.1. Incubate the inoculated brilliant-green lactose bile broth tube *for 48 ± 3 hours* at 35° to 37° C.

1.2.2. The formation and presence of gas in any amount in the inverted vial of the fermentation tube at any *time within 48 ± 3 hours constitutes* a Confirmed Test.

1.2.3. If the brilliant-green lactose bile broth tube is decolorized before or at the end of the forty-eight hour incubation period, the Completed Test, as in "D" below, should immediately be performed. (It has been suggested that when such decolorization, probably due to *Cl. welchii*, takes place, a transfer should be made at once to broth containing 2 per cent dried bile and 1:25,000 brilliant-green or to formate ricinoleate broth. If gas appears within 48 ± 3 hours at 35° to 37° C., the culture should be submitted to the Completed Test.)

## D. Completed Test

### *1. Procedure*

The Completed Test may be performed upon the lactose broth tubes *showing* gas, the colonies found upon plates used for the Confirmed Test (C, 1.1), or the brilliant-green lactose bile broth tubes, showing gas, used for the Confirmed Test (C, 1.2).

1.1. Lactose broth tubes. If the lactose broth tubes are used for the Completed Test, the choice of these tubes to be tested shall be that specified for the Confirmed Test in "C."

1.1.1. Streak one or more Endo or eosin methylene-blue plates from each lactose broth tube to be tested. Careful attention to the following details, when streaking plates, will result in a high proportion of successful isolations if coliform organisms are present:

*a.* Employ a straight needle slightly curved at the tip. By bringing only the curved section of the needle in contact with the agar surface, the latter will not be scratched or torn.

*b.* Incline the lactose broth tube to avoid picking up any membrane or scum on the needle.

*c.* Insert the end of the needle into the liquid in the tube to a depth of approximately 1.0 mm.

*d* Then streak the plate, covering completely the whole agar surface.

Incubate the plate (inverted, if without porous cover) at 35° to 37° C. for 24 ± 2 hours.

1.2. Brilliant-green lactose bile broth tubes. If the brilliant-green lactose bile broth tubes used for the Confirmed Test are to be employed for the Completed Test, streak one or more Endo or eosin methylene-blue plates from each brilliant-green lactose bile broth tube showing gas, as soon as possible after appearance of gas, following closely the directions indicated in 1.1. Incubate the plates at 35° to 37° C. for 24 ± 2 hours.

1.3. Identification. From each of the plates used for the Confirmed Test, or from those made from the *lactose broth or brilliant-green lactose bile broth* tubes (D. 1.1 or 1.2), fish one or more typical Escherichia coli colonies; or, if no such

typical colonies are present, fish two or more colonies considered most likely to consist of organisms of the coliform group, transferring each to an agar slant and a lactose broth fermentation tube.

When transferring colonies, care should be taken to choose, if possible, well isolated colonies separated by at least 0.5 cm. from other colonies, and barely to touch the surface of the colony with the needle in order to minimize the danger of transferring a mixed culture.

The secondary lactose broth fermentation tubes thus inoculated shall be incubated at 35° to 37° C. until gas formation is noted—the incubation not to exceed 48 ± 3 hours.

The agar slants shall likewise be incubated at 35° to 37° C. for 24 to 48 ± 3 hours, and Gram-stained preparations from those corresponding to the secondary lactose broth tubes that show gas shall be examined microscopically.

1.4. Results. The formation of gas in lactose broth and the demonstration of Gram-negative, non-spore-forming bacilli in the agar culture shall be considered a satisfactory Completed Test, demonstrating the presence of a member of the coliform group.

The absence of gas formation in lactose broth or failure to demonstrate Gram-negative non-spore-forming bacilli in a gas-forming culture constitutes a negative test.

When spore-forming lactose-fermenting organisms are found, the culture should be further studied to ascertain the possible presence of bacteria of the coliform group associated with the spore-bearing organisms. This may be done by transferring the culture to formate ricinoleate broth and incubating at 35° to 37° C. for 48 ± 3 hours.

If no gas is produced, only spore-forming lactose fermenters may be considered to be present. If gas is produced in the formate ricinoleate broth, the probable presence of coliform group organisms should be verified by inoculation from the formate ricinoleate to a tube of standard lactose broth and to an agar slant.

If, after 48 ± 3 hours, gas is produced in the former and no spores in the latter, the test may be considered "completed" and the presence of coliform organisms demonstrated.

If spores are present, for practical purposes, organisms of the coliform group may be considered absent.

## E. Technic for the Gram Stain

The "Completed Test" for coliform group organisms includes the determination of Gram stain characteristics of the organisms isolated.

A word of caution is necessary regarding the interpretation of Gram stain results. Organisms are so generally recorded in the literature as either Gram-positive or Gram-negative, that this stain is often considered to give a clear-cut reaction as definite as a chemical test. Many organisms, however, are actually Gram-variable; and to determine their predominant tendency in this respect, repeated tests are needed.

There are a large variety of modifications of the Gram stain, many of which have been listed by Hucker and Conn. The following Hucker modification is valuable for staining smears of pure cultures.

### *1. Reagents*

1.1. Ammonium oxalate crystal violet.

1.1.1. Solution A. Dissolve 2 g. of crystal violet, with 85 per cent dye content, in 20 ml. of 95 per cent ethyl alcohol.

1.1.2. Solution B. Dissolve 0.8 g. of ammonium oxalate in 80 ml. of distilled water.

1.1.3. Mix solutions A and B ordinarily in equal parts. It is sometimes found, however, that this gives so concentrated a stain that Gram-negative organisms, such as the gonococcus, do not properly decolorize. To avoid this difficulty, solution A may be diluted as much as ten times and 20 ml. of the diluted solution mixed with an equal quantity of solution B.

1.2. Lugol's Solution; Gram's Modification. Dissolve 1 g. of iodine crystals, and 2 g. of potassium iodide in 300 ml. of distilled water.

1.3. Counterstain. Make an alcoholic solution of safranin dye by dissolving 2.5 g. in 100 ml. of 95 per cent ethyl alcohol.

Add 10 ml. of the alcoholic solution of safranin to 100 ml. of distilled water.

### 2. Procedure

Stain the smear for one minute with the crystal violet solution. Wash slide in water; immerse in iodine solution for one minute.

Wash stained slide in water; blot dry. Decolorize with 95 per cent ethyl alcohol for thirty seconds; use gentle agitation.

Blot and cover with counterstain for ten seconds. Then wash, dry, and examine as usual.

Cells which decolorize and accept the safranin stain are Gram-negative. Cells which so not decolorize, but retain the crystal violet stain, are Gram-positive.

## F. Selection of Coliform Tests

The laboratory worker, when he elects to apply either the Presumptive, Confirmed or the Completed Test for the coliform group, shall be guided by the following basic considerations.

### 1. Presumptive Test

The Presumptive Test may be applied to gas-forming portions of:

—any sample of sewage, sewage effluent (except chlorinated effluent) or water known to be heavily polluted, the fitness of which for use as drinking water is not under consideration.

—any routine sample of raw water in a purification plant, provided that records indicate the Presumptive Test to be not too inclusive for the production of data statistically comparable to that obtained from the finished water.

### 2. Confirmed Test

The Confirmed Test may be applied to the gas-forming portions:

—in the examination of any water to which the Presumptive Test is known, from previous records, to be not applicable.

—in the routine examination of samples of drinking water, water in process of purification and finished waters.

—in the examination of chlorinated sewage effluents.

### 3. Completed Test

The Completed Test shall be applied to the gas-forming portions:

—in the examination of any water to which the applicability of the Confirmed Test is in reasonable doubt. Laboratories responsible for the quality of the raw or finished water supplied to large communities shall employ the Completed Test, if not exclusively to these raw or finished waters, at least to such a proportion of samples as to establish beyond reasonable doubt the applicability to them of the Confirmed Test.

## PUBLIC HEALTH SERVICE DRINKING WATER STANDARDS

Standards Promulgated by the United States Public Health Service, Federal Security Agency, February 5, 1946, for Drinking and Culinary Water Supplied by Carriers Subject to the Federal Quarantine Regulations

3.2 *Application.* Applications 3.21 and 3.22 given below shall govern when ten milliliter (10 ml.) portions are used and applications 3.23 and 3.24 shall govern when one hundred milliliter (100 ml.) portions are used.

3.21 Of all the standard ten milliliter (10 ml.) portions examined per month in accordance with the specified procedure, not more than ten (10) per cent shall show the presence of organisms of the coliform group.

3.22 Occasionally three (3) or more of the five (5) equal ten milliliter (10 ml.) portions constituting a single standard sample may show the presence of organisms of the coliform group, provided that this shall not be allowable if it occurs in consecutive samples or in more than:

*a*) Five (5) per cent of the standard samples when twenty (20) or more samples have been examined per month.

*b*) One (1) standard sample when less than twenty (20) samples have been examined per month.

Provided further that when all five of the standard one hundred milliliter (100 ml.) portions constituting a single standard sample show the presence of organisms of the coliform group, daily samples from the same sampling point shall be collected promptly and examined until the results obtained from at least two consecutive samples show the water to be of satisfactory quality.

3.25 The procedure given, using a standard sample composed of five standard portions, provides for an estimation of the most probable number of coliform bacteria present in the sample as set forth in the following tabulation:

| *Number of portions* | | *Most probable number of coliform bacteria per 100 ml.* | |
|---|---|---|---|
| *Negative* | *Positive* | *When 5–10 ml. portions are examined* | *When 5–100 ml. portions are examined* |
| 5 | 0 | Less than 2.2 | Less than 0.22 |
| 4 | 1 | 2.2 | .22 |
| 3 | 2 | 5.1 | .51 |
| 2 | 3 | 9.2 | .92 |
| 1 | 4 | 16.0 | 1.60 |
| 0 | 5 | More than 16.0 | More than 1.60 |

## INFORMATION ON WELLS

Well No. or designation____________ Date____________ Est. No.__________

1. Depth?__________ 2. Size of well bore?__________ 3. Drilled or dug?__________

4. Strata (soil) through which well is dug or drilled?__________

5. Nature of bottom of well?____ 6. Height of water in well?____ 7. How pumped?____

8. Location at plant in respect to buildings, cattle pens, sewers, etc.__________

9. Approximate capacity or yield?__________

10. Does it show seasonal changes of any kind?__________

11. Is it affected by prolonged or heavy rains?__________

12. Proximity to river, pond, swamp, or surface water?__________

13. Describe top of well:

*a*. Protection from surface water and height of top above surface water?________

________________________________________

________________________________________

*b*. Height of casing above or below ground level?________________

*c*. Surface level on low or high ground?____________________

*d*. Nature of slope of ground to or from well with relation to plant, rivers, other surface water?____________________________

________________________________________

14. Where is water from this well pumped?____________________

15. Where can samples of this well be taken?

*a*. Tap at pump?__________ *b*. Tap in direct line from pump?__________

*c*. Outlet at reservoir or other points?____________________

16. How long has well been in use?____________________

*a*. Has it been pumped continually or intermittently?____________

17. Other information:____________________________

________________________________________

________________________________________

Signed____________________

## COOK PORK AND ITS PRODUCTS THOROUGHLY*

Pork forms an important part of the diet in most American families. As with many other foods, certain hygienic precautions are needed in preparing pork for food purposes. Most fruits and vegetables are washed or peeled. Milk is commonly pasteurized to destroy harmful bacteria that may be present. Water supplies are treated, if necessary, for purification and safety to health. Proper cooking is a valuable scientific safeguard in the case of numerous foods, including pork. Fresh pork should always be cooked so that it is "done" throughout.

### REASONS FOR THOROUGH COOKING

Cooking is necessary since a small percentage of hogs harbor a parasite known scientifically as *Trichinella spiralis*. The common name of the parasites is trichinæ. They are extremely small and are not seen except upon microscopic examination. Even then they are likely to escape detection. The parasites cause hogs that survive the disease no particular inconvenience so far as can be judged from the external appearance of these animals, and when pork from affected hogs is cooked the organisms are no more dangerous than bacteria in pasteurized milk, in purified water, or in canned vegetables. But failure to cook fresh pork thoroughly may result in a condition known as trichinosis.

The seriousness of this ailment depends on the number of live trichinæ in the pork eaten. Slight infestation following the consumption of moderate quantities

* Series A. I. 39 United States Department of Agriculture, Bureau of Animal Industry.

of lightly infested pork that is raw or imperfectly cooked may pass unnoticed or may cause but slight illness. But the consumption of heavily infested pork or of large quantities of raw or imperfectly cooked pork that is lightly infested may produce a painful and sometimes fatal attack of trichinosis. Common symptoms are nausea, vomiting, diarrhea, severe abdominal pains, general dullness, weakness, twitching of muscles, and sensations of tension and pain in the muscles. In later stages of the disease the eyeballs may become inflamed or show small hemorrhages. Swelling of the legs, forearms, abdominal wall, and face may occur, sometimes with skin eruptions. Muscular pain is an outstanding symptom of trichinosis. Fever is commonly present during the first stage of the disease, reaching its height in about 10 days after the first symptoms. The symptoms are by no means constant, and typical cases have sometimes been diagnosed as typhoid fever, undulant fever, meningitis, and other diseases. When patients are seen by a physician within a few days after eating the trichinous pork and the disease is correctly diagnosed, some good may follow attempts to expel the parasites from the digestive tract.

## MAIN SOURCES OF TRICHINOSIS

The disease is most commonly found among persons of foreign origin or descent. The reason is that people of certain European countries often retain their native fondness for raw or imperfectly cooked pork. Trichinosis is not limited to people of such foreign descent, however, since many affected persons have been of American birth or of American ancestry.

Outbreaks of trichinosis occur at all seasons of the year but usually in winter, especially during the holidays when various products containing pork are eaten without proper cooking in some households. Besides fresh pork and sausage, and smoked hams and shoulders, and bacon that may not be thoroughly cooked, such products as smoked sausage, boneless loins, capicola, coppa, and forms of dry or summer sausage, if prepared in establishments not operated under Federal meat inspection or other competent inspection, are the main sources of trichinosis in this country.

There are cases of entire families being stricken as a result of eating uncooked or improperly cooked sausage or other products made from the meat of one hog. Even tasting uncooked sausage during its preparation to ascertain when the seasoning is satisfactory may cause trichinosis. The consumption of hastily cooked hamburgers consisting of a mixture of ground beef and pork is likely to cause trichinosis. Numerous cases have resulted from the serving of uncooked pork products at a family gathering or reunion. In such cases the meat is usually from one hog and is more dangerous in this respect than pork products which are the composite result of the meat from many hogs, as in packing-house products. When the meat is obtained from several hogs, the chance of many of the parasites being present is reduced.

## PORK IS NOT INSPECTED FOR TRICHINAE

There is no practicable system of inspection by which persons who eat uncooked pork can be protected from trichinae. Under Federal meat inspection pork is not examined microscopically for trichinae. Although microscopic inspection would perhaps eliminate most of the heavily infested hog carcasses, many which would be dangerous were the meat eaten without proper treatment would be overlooked.

In the United States, in establishments operating under Federal meat inspection, pork products of any kind that are customarily eaten without cooking by the consumer are especially processed to destroy trichinae and are thus rendered safe. These methods of processing, which involve cooking, special freezing, or special curing, are conducted under the close scrutiny of the inspector. The methods other than cooking are not applicable to the preparation of pork products in the home and on the farm.

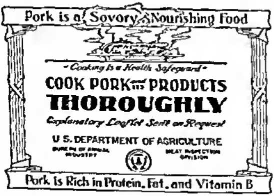
## LARGE PIECES REQUIRE MORE COOKING

In cooking pork, remember that large pieces require much more cooking than small ones because the heat penetrates slowly into the center of the meat. Large pieces that are well cooked on the outside may be imperfectly cooked or even entirely raw at the center. The housewife should, therefore, use care in preparing pork to see that it is thoroughly cooked throughout if *trichinosis* is to be avoided. Particular care should be taken in cooking pork chops well done to the bone. A good test for "doneness" of chops and also of loin roasts is to make small incisions next to the bone as well as into the thicker part of the meat to be sure that the meat is thoroughly cooked. For hams and shoulders the only sure guide to sufficient cooking is a meat thermometer stuck into the center of the thickest portion of the cut to show when the meat is well done all through. However, 30 minutes to the pound is an approximate guide to sufficient cooking of large thick cuts of pork. The consumer is reminded also that frozen or very cold meat requires a longer period of cooking than meat of ordinary temperature. Processed sausage should always be cooked unless the consumer knows definitely that these products were especially processed, under Federal supervision or equally reliable State or local supervision, to be eaten without cooking. Sausage purchased from farmers and peddlers should be cooked in all cases.

The thorough cooking of pork is advisable not only for hygienic reasons, but also for the development of a rich flavor. The Bureau of Home Economics, U. S. Department of Agriculture, makes the following recommendations: "Success in preparing pork cuts depends on regulating the heat so as to cook the meat well done to the center of the piece, and at the same time to keep the outside from becoming hard and dry. Moderate cooking temperature is best after the surface has been browned to develop rich flavor."

## THE POSTER IS A REMINDER

As a reminder to the public, the United States Department of Agriculture has prepared a poster, similar to the one reproduced herewith, entitled "Cook Pork and Its Products Thoroughly." It has been prepared for display in meat shops. The display of this poster is entirely voluntary and represents the cooperation of the meat trade with the United States Department of Agriculture for the benefit of the public.




## OUTLINE FOR THE PREPARATION OF GOVERNING LEGISLATION AND A PROPOSED CODE FOR THE INSPECTION OF HUMAN FOOD

Report of the Committee on Food and Milk Hygiene adopted at the Ninety-Second Annual Meeting of the American Veterinary Medical Association in Minneapolis, August 15-18, 1955

## Appendix

### Outline for the Preparation of Governing Legislation

The outline here presented is suitable for use by states, counties, municipalities, and other political subdivisions. It provides for the protection of the public health by preventing the use in trade channels of food that is diseased, unsound, unwholesome, or otherwise unfit for human consumption and is designed also to prevent the misbranding and adulteration of foods. It provides further for the proper disposal of unfit and misbranded foods. It provides for establishing local agencies that can act in cooperation with livestock and public health organizations in the control of diseases of animals and man, thus safeguarding the livestock industry and promoting the public welfare.

The Special Committee on Food Hygiene of the American Veterinary Medical Association has concluded that these purposes can best be accomplished by the organization of a coordinated food-control program under veterinary planning and direction. An outline of the salient features that should be included in proposed legislation follows.

To effect this purpose the legislation should include:

### Inspection of Human Food

(*1*) *Title.*—A statement of the purpose of the enactment.

(*2*) *Definitions.*—Definitions clearly setting out: (*a*) The office responsible for the inspection; (*b*) definition of the term "meat" (to include, with proper designation, the flesh of all food animals, including poultry); (*c*) definitions of other foods; (*d*) definitions of other special terms used in the enactment.

(*3*) *Administration.*—Provision for the appointment of a qualified veterinarian-in-charge to enforce this enactment, with authority to appoint such assistants as he may deem necessary.

(*4*) *Licenses.*—A clear statement of the significance of licensing provisions and a statement of the procedures involved in granting licenses upon application and the circumstances under which licenses may be revoked.

(*5*) *Plant Construction and Equipment.*—A statement in general language, broad enough to permit the office responsible for inspection to meet changing conditions, prescribing the required type of construction of plants and the character and installation of equipment and necessary facilities for handling products, and for conduct of the inspection with the more important features mentioned specifically, showing the requirements for maintaining clean premises.

(*6*) *Antemortem Inspection.*—A provision for antemortem inspection by veterinarians or under veterinary supervision on the day of slaughtering, stating in general the facilities for this purpose which the plant operator must provide, and including in general language broad principles to guide veterinary inspectors in disposing of animals showing deviations from the normal.

(*7*) *Postmortem Inspection.*—Provision for thorough postmortem inspection, at the time of slaughter, by veterinarians with provision for nonveterinary assistants, stating generally the requirements which the plant operator must meet to present carcasses and parts for inspection and to handle dressing operations properly, and giving in general language principles governing the disposal of diseased carcasses and parts, which will serve to guide veterinary inspectors.

(*8*) *Time of Operations.*—Provision for the veterinarian-in-charge to designate the hours of the day and the days of the week during which plants may be operated when few animals are slaughtered or when but a small quantity of product is prepared.

(*9*) *Preparation and Handling.*—Provision for adequate inspection of meat and other foods during their preparation and handling, whether in the packing plant, wholesale distributing plant, retail market, restaurant, or other food-handling establishment.

(*10*) *Inspection Legend.*—Provision for marking inspected and passed meat and products with a specified inspection legend with a number identifying the plant, this to be applied in a prescribed form whether by branding on the product or printing on labels.

(11) *Marking and Labeling.*—Provision for adequate labeling (and adequate marking of unlabeled product) to prevent deception and to inform the purchaser as to the common or usual name of the product; the ingredients with which it was prepared; the name and address of the manufacturer, packer, or distributor; and an accurate statement of the quantity of contents in terms of weight, measure, or numerical count, whichever is appropriate. In order to make the label control effective, it is necessary also that provision be made for control of the composition of products prepared with two or more ingredients to insure preparation with proper ingredients and distribution under commonly understood names.

(12) *All Products to Be Inspected.*—Provision for inspection of all products, within the jurisdiction, in accordance with this enactment, except that inspections by other agencies acceptable to the veterinarian-in-charge will be recognized.

(13) *Access to Premises.*—Provision for access by inspectors at any time to all parts of premises covered by the enactment.

(14) *Seizure.*—Provision for seizure of product wherever found, within the jurisdiction, in the channels of trade, when the inspector has reasonable cause to believe that the product is unfit for food, adulterated, or misbranded.

(15) *Disposal of Retained or Seized Products.*—Authority for inspectors summarily to dispose of retained or seized products, and to condemn, and to require under the supervision of an inspector the destruction for food purposes of diseased animals, carcasses, parts of carcasses, and unfit or adulterated products, and to require that misbranded products be made to conform to the requirements of this enactment.

(16) *Appeals.*—Provision for appeal from the decision of an inspector to his immediate superior having jurisdiction over the subject matter of the appeal.

(17) *Rules and Regulations.*—Authority for the inspection agency to promulgate rules, regulations, and orders implementing the broad terms of the enactment and consistent with it.

(18) *Financing.*—Provision for financing the inspections required by this enactment through the permanent establishment of an adequate, annual appropriation.

(19) *Reports.*—Provision for reporting of inspections by inspectors, and the furnishing of information for that purpose by plant operators and owners of products inspected.

(20) *Cooperation with Other Agencies.*—Provision for the veterinarian-in-charge to exchange information with public health and other disease control agencies.

(21) *Penalties.*—Penalties for failure to comply with any portion of the enactment or rules, regulations, and orders properly issued thereunder.

(22) *Saving Clause.*—A provision whereby the invalidation of any section will not affect the legality of the remainder of the enactment.

## Proposed Code for the Inspection of Human Food*

### Food Inspection Act

An act relating to the public health, safety, and welfare, providing for: the establishment of a food inspection service; the inspection of articles of human food; the condemnation and destruction for food purposes of diseased, unsound, or otherwise unfit food, the prevention of misbranding and adulteration of food; the issuance of licenses and collection of fees, the adoption of regulations for the administration of the Act, and penalties for violations of the Act.

BE IT ENACTED BY THE
LEGISLATURE OF THE STATE OF
COMMISSIONERS OF THE COUNTY OF ——:
COUNCIL OF THE CITY OF

* This code was primarily designed to cover meat and meat products, but may be broadened so as to apply to foods of milk, marine, or other origin when not in conflict with specific codes intended for those products. The term "ordinance" may be substituted throughout for "act" in the case of county or city enactments.

### Section 1.—Definitions

For the purpose of this Act the following words, phrases, names, and terms shall be construed, respectively, to mean:

(*a*) *Service.*—The Food Inspection Service established by this Act.

(*b*) *Inspector.*—An inspector of the Service, authorized by the Chief of Service to do any work or perform any duty in connection with food inspection under this Act.

(*c*) *Licensed Plant.*—Any food-handling plant licensed under this Act.

(*d*) *Food.*—Any article capable of being used for human food and which is subject to regulation by the

$\left\{\begin{array}{l}\text{State}\\ \text{County of}\\ \text{City}\end{array}\right\}$ ________.

(*e*) *Animal.*—Cattle, calves, sheep, swine, goats, and other domestic food animals, including poultry.

(*f*) *Carcass.*—All parts, including viscera, of a slaughtered animal that are capable of being used for human food.

(*g*) *Meat and Product; Meat or Product.*—Carcasses, parts of carcasses, meat and products of, or derived from, cattle, calves, sheep, swine, goats, and other domestic food animals including poultry, which are capable of being used for human food.

(*h*) *Person.*—Natural person, partnership, corporation or other organization, and every officer, agent, or employee thereof. This term shall mean either the singular or the plural as the case may be.

### Section 2.—Administration

(*a*) *Organization of Service.*—There shall be organized a Food Inspection Service which shall be charged with the enforcement of this Act.

(*b*) *Chief of Service.*—The Chief of Service shall be a duly qualified veterinarian, graduate of a school approved by the American Veterinary Medical Association.

(*c*) *Inspectors; Qualifications; Appointments.*—The Chief of Service shall cause to be appointed such inspectors as may be necessary to carry out the provisions of this Act. Appointees shall meet all applicable civil service rules and regulations: Provided, That veterinary inspectors shall be duly qualified veterinarians, graduates of schools approved by the American Veterinary Medical Association and Provided Further, That other inspectors shall meet such qualifications as the Chief of Service may prescribe.

### Section 3.—Licenses

(*a*) *Licensee.*—No person shall operate any slaughtering plant, packing plant, wholesale distributing plant, retail market, restaurant, or other food-handling establishment unless he shall first have applied for and been granted a license as provided under this Act.

(*b*) *Application for License.*—The owner or operator of each plant or establishment of the kind specified in (*a*) of this section shall make application to the Chief of Service for a license to operate such plant. The application shall be on a form furnished by the Service. In case of change of ownership or change of location a new application shall be made.

(*c*) *Granting License.*—The Chief of Service shall investigate all circumstances in connection with the application for license to determine whether the applicable requirements of this Act and regulations made pursuant thereto have been complied with. The Chief of Service shall grant or refuse the license upon the basis of facts pertaining to the applicable requirements disclosed by his investigation. Each license shall bear an identifying number.

(*d*) *Revocation of License.*—The Chief of Service may revoke any license if he determines that any false statement was made in the application or if he finds that

there is any failure to comply with the applicable provisions of this Act or regulations made pursuant thereto.

### Section 4.—Plant Construction and Equipment

(a) *Construction.*—Every licensed plant shall be constructed and maintained with materials susceptible of being readily and thoroughly cleaned. The plant shall not be located near any source of fly breeding or similar public nuisance. Rooms and compartments used for handling or preparing food products shall be separate and distinct from those used for handling or preparing inedible products. Floors and walls shall be smooth and impervious. An efficient drainage system with approved traps and vents shall be provided. There shall be ample light and ventilation. Suitable dressing rooms, toilet rooms, and urinals shall be provided. Modern hand-washing facilities shall be located wherever necessary to assure cleanliness of persons handling food.

(b) *Equipment.*—Every licensed plant shall provide for proper handling of food and efficient conduct of inspection of all necessary tables, benches, receptacles, utensils, and other articles of equipment of such materials and construction as will make them susceptible of being readily and thoroughly cleaned.

(c) *Cleanliness.*—The outer premises and all parts of a licensed plant and its equipment shall be kept clean. Flies, rats, and other vermin shall be excluded from such plants.

(d) *Water Supply and Sewage Disposal.*—The water supply of a licensed plant shall be ample, clean, and potable and protected against contamination and pollution. An ample supply of both hot and cold water shall be distributed throughout the plant as may be necessary. An adequate and acceptable sewage disposal system shall be provided.

### Section 5.—Ante-mortem Inspection

(a) *Provision for Ante-mortem Inspection.*—The Chief of Service may require to be made, by an inspector, an ante-mortem inspection of all animals about to be slaughtered. Such inspection shall be made on the day of slaughter. No animal shall be slaughtered without such inspection as the Chief of Service may require under this section.

(b) *Facilities and Assistance.*—The owner or operator of each licensed plant where slaughtering is conducted shall furnish such facilities and assistance as may be required by the Chief of Service to permit the inspector to make his inspections efficiently.

(c) *Disposition of Animals.*—Veterinary inspectors shall dispose of animals on ante-mortem inspection in conformity with such provisions of the appropriate federal inspection regulations as may be adopted by the Chief of Service from time to time in his regulations under this Act, whether the animals are released for slaughter, held as suspects, or condemned.

### Section 6.—Post-mortem Inspection

(a) *Provision for Post-mortem Inspection.*—The Chief of Service may require that meat or product be derived from carcasses that have received and passed a post-mortem inspection made at the time of slaughter. No meat or product shall be prepared or distributed in the channels of trade without having received such post-mortem inspection as the Chief of Service may require under this section.

(b) *Facilities and Assistance.*—The owner or operator of each licensed plant where slaughtering is conducted shall furnish such facilities as may be required by the Chief of Service to permit the efficient conduct of post-mortem inspection and to maintain the identity of all carcasses with their respective parts until the inspection has been completed.

(c) *Disposition of Carcasses.*—Veterinary inspectors shall dispose of carcasses on post-mortem inspection in conformity with such provisions of the appropriate federal inspection regulations as may be adopted by the Chief of Service from time

to time in his regulations under this Act, whether the carcasses are passed for food or condemned.

### SECTION 7.—TIME OF OPERATION

(a) *Time of Operation.*—The Chief of Service may require operations at licensed plants to be conducted during reasonable hours. The owner or operator of each licensed plant shall keep the Chief of Service informed in advance of intended hours of operations. When one inspector is detailed to make inspections at two or more plants where few animals are slaughtered or where but a small quantity of food is prepared, the Chief of Service may designate the hours of the day and the day of the week during which such plants may be operated.

### SECTION 8.—PREPARATION AND HANDLING

(a) *Food Subject to Inspection.*—All food in the channels of trade, whether fresh, frozen, cured, or otherwise prepared, even though previously inspected and passed, shall be subject to reinspection by Service inspectors as often as may be necessary in order to ascertain whether such food is sound, healthful, wholesome, and fit for human food. If upon reinspection any food is found to have become unsound, unhealthful, unwholesome, or in any way unfit for human food, it shall be condemned: PROVIDED, That when a food is found to be affected by any unsound or unwholesomo condition that can be satisfactorily removed by methods approved by the Chief of Service, such food may be so reconditioned under the direction of a Service inspector. If upon final inspection the food is found to be sound and wholesome, it shall be passed for human food; otherwise it shall be condemned.

(b) *Processing Operations to be Conducted Under Inspection.*—The owner or operator of each licensed plant shall inform the Chief of Service in advance regarding any food-processing operations such as canning, cooking, curing, smoking, salting, rendering, freezing, et cetera at his plant, and shall conduct such operations only at such times and in such manner as the Chief of Service may prescribe to assure clean handling of food and afford opportunity for inspection.

(c) *Chemical Preservatives Et Cetera.*—No food shall contain any dye, chemical, preservative, or other substance which impairs its wholesomeness or which is not approved by the Chief of Service.

(d) *Trichinae.*—Inasmuch as it can not certainly be determined, by any present known method of inspection, whether the muscle tissue of pork contains trichinae, and inasmuch as live trichinae are dangerous to health, no article of a kind prepared customarily to be eaten without cooking shall contain any muscle tissue of pork unless the pork has been subjected to a temperature sufficient to destroy all live trichinae, or other treatment prescribed by the Chief of Service.

### SECTION 9.—INSPECTION LEGEND†

(a) *Inspection Legend Prescribed.*—An inspection legend embodying the license number shall be applied by an employee of the licensed plant, under the supervision of an inspector, to such meat and product processed in such plant as the Chief of Service may require to be so marked. The inspection legend shall be in such form and design as the Chief of Service may prescribe to indicate that the food has been inspected and passed in accordance with this Act. At the discretion of the Chief of Service, the inspection legend and license number may be used on other foods processed at licensed plants.

### SECTION 10.—LABELING

(a) *False or Deceptive Names.*—No label or mark on any food shall convey any false impression of identity, quality, or origin, and no container or covering of a food shall be so made, formed, or filled as to be deceptive or misleading.

† The brand to be used in applying the mark of inspection should be of a shape different than the round brand used by the Federal Meat Inspection Service, in order to render less difficult the distinction between the inspection marks of the two services.

(b) *Labels.*—The Chief of Service may require food to bear such labels or marks as may be necessary to prevent deception. The label of a food shall include, prominently and informatively displayed: (1) the common or usual name of the product; (2) a list of the ingredients used in preparing the food if it is fabricated from two or more ingredients; (3) the name and place of business of the manufacturer, packer, or distributor; and (4) an accurate statement of the quantity of the contents.

(c) *Composition of Food.*—The Chief of Service may prescribe such rules and regulations as may be necessary to control effectively the composition and processing of food for the purpose of preventing deception.

### Section 11.—Access to Premises

(a) *Access to Premises.*—Inspectors shall be entitled to access at any time upon proper identification at all regular entrances and to all parts of premises for the purpose of making inspection under this Act.

### Section 12.—Embargo and Seizure—Disposal of Seized Food

(a) *Embargo and Seizure.*—The Chief of Service is authorized to prohibit the importation into the channels of sale of this jurisdiction food that is unsound, unwholesome, improperly labeled, or otherwise not in accordance with this Act. Any food found in the channels of sale within this jurisdiction by a Service inspector to be not in accordance with this Act shall be subject to seizure and confiscation by the Service inspector.

(b) *Disposal of Seized Food.*—Seized food shall be condemned by a Service inspector unless it is of such character that it can be made to conform with this Act by methods approved by the Chief of Service. Condemned food shall be effectively destroyed for food purposes by the owner or handler of the food under the supervision of an inspector in such manner as the Chief of Service may prescribe.

(b) *Information to Be Furnished by Owners and Operators.*—The owner or operator of each licensed plant shall furnish to Service inspectors accurate information as to all matters needed by them for making their reports.

### Section 17.—Cooperation with Other Agencies

(a) *Cooperation with Other Agencies.*—The Chief of Service is authorized and directed to maintain a close working relationship with other public health and disease control agencies to arrange a full exchange of information and correlate their respective activities.

### Section 18.—Inspection—Penalties

(a) *Scope of This Act.*—This Act shall have effect throughout the {State / County / City} of————.

(b) *All Food Subject to Inspection.*—No food shall be handled or transported in the channels of trade within the purview of this Act without such inspection as the Chief of Service may prescribe under this Act, except that a comparable inspection by an appropriate agency of the federal government or other agencies may be accepted by the Chief of Service.

(c) *Penalties.*—Any person violating any of the provisions of this Act, or the rules, regulations, or orders properly issued thereunder, upon conviction, shall be deemed guilty of a misdemeanor and punished by a fine not to exceed $————, or imprisonment for a period of not more than ————, or both such fine and imprisonment at the discretion of the court.

### Section 19—Saving Clause

(a) *Saving Clause.*—If any section, paragraph, or sentence of this Act, or its application to any person, or in particular circumstances, is for any reason held to be invalid, such decision shall not affect the validity of remaining portions of this Act or its application to other persons or in other circumstances.

### Section 20.—Inconsistent Acts

(a) *Inconsistent Acts.*—Insofar as they conflict with the provisions of this Act previous acts of this jurisdiction are superseded.

### Section 21.—Effective Date

(a) *Effective Date.*—This Act shall take effect and be in force from and after————

## THE MEAT-INSPECTION ACT

Extract from an act of Congress entitled "An act making appropriations for the Department of Agriculture for the fiscal year ending June thirtieth, nineteen hundred and seven," approved June 30, 1906 (34 Stat. 674), and from an act of Congress entitled "An act making appropriations for the Department of Agriculture for the fiscal year ending June thirtieth, nineteen hundred and eight," approved March 4, 1907 (34 Stat. 1260).

[1] That hereafter, for the purpose of preventing the use in interstate or foreign commerce, as hereinafter provided, of meat and meat food products which are unsound, unhealthful, unwholesome, or otherwise unfit for human food, the Secretary of Agriculture, at his discretion, may cause to be made, by inspectors appointed for that purpose, an examination and inspection of all cattle, sheep, swine, and goats before they shall be allowed to enter into any slaughtering, packing, meat-

canning, rendering, or similar establishment, in which they are to be slaughtered and the meat and meat food products thereof are to be used in interstate or foreign commerce; and all cattle, swine, sheep, and goats found on such inspection to show symptoms of disease shall be set apart and slaughtered separately from all other cattle, sheep, swine, or goats, and when so slaughtered the carcasses of said cattle, sheep, swine, or goats shall be subject to a careful examination and inspection, all as provided by the rules and regulations to be prescribed by the Secretary of Agriculture as herein provided for.

[2] That for the purposes hereinbefore set forth the Secretary of Agriculture shall cause to be made by inspectors appointed for that purpose, as hereinafter provided, a post-mortem examination and inspection of the carcasses and parts thereof of all cattle, sheep, swine, and goats to be prepared for human consumption at any slaughtering, meat-canning, salting, packing, rendering, or similar establishment in any State, Territory, or the District of Columbia for transportation or sale as articles of interstate or foreign commerce; and the carcasses and parts thereof of all such animals found to be sound, healthful, wholesome, and fit for human food shall be marked, stamped, tagged, or labeled as "Inspected and Passed;" and said inspectors shall label, mark, stamp, or tag as "Inspected and Condemned," all carcasses and parts thereof of animals found to be unsound, unhealthful, unwholesome, or otherwise unfit for human food; and all carcasses and parts thereof thus inspected and condemned shall be destroyed for food purposes by the said establishment in the presence of an inspector, and the Secretary of Agriculture may remove inspectors from any such establishment which fails to so destroy any such condemned carcass or part thereof, and said inspectors, after said first inspection shall, when they deem it necessary, reinspect said carcasses or parts thereof to determine whether since the first inspection the same have become unsound, unhealthful, unwholesome, or in any way unfit for human food, and if any carcass or any part thereof shall, upon examination and inspection subsequent to the first examination and inspection, be found to be unsound, unhealthful, unwholesome, or otherwise unfit for human food, it shall be destroyed for food purposes by the said establishment in the presence of an inspector, and the Secretary of Agriculture may remove inspectors from any establishment which fails to so destroy any such condemned carcass or part thereof.

[3] The foregoing provisions shall apply to all carcasses or parts of carcasses of cattle, sheep, swine, and goats, or the meat or meat products thereof which may be brought into any slaughtering, meat-canning, salting, packing, rendering, or similar establishment, and such examination and inspection shall be had before the said carcasses or parts thereof shall be allowed to enter into any department wherein the same are to be treated and prepared for meat food products; and the foregoing provisions shall also apply to all such products which, after having been issued from any slaughtering, meat-canning, salting, packing, rendering, or similar establishment, shall be returned to the same or to any similar establishment where such inspection is maintained.

[4] That for the purposes hereinbefore set forth the Secretary of Agriculture shall cause to be made by inspectors appointed for that purpose an examination and inspection of all meat food products prepared for interstate or foreign commerce in any slaughtering, meat-canning, salting, packing, rendering, or similar establishment, and for the purposes of any examination and inspection said inspectors shall have access at all times, by day or night, whether the establishment be operated or not, to every part of said establishment; and said inspectors shall mark, stamp, tag, or label as "Inspected and Passed" all such products found to be sound, healthful, and wholesome, and which contain no dyes, chemicals, preservatives, or ingredients which render such meat or meat food products unsound, unhealthful, unwholesome, or unfit for human food; and said inspectors shall label, mark, stamp, or tag as "Inspected and Condemned" all such products found unsound, unhealthful, and unwholesome, or which contain dyes, chemicals, preservatives, or ingredients which render such meat or meat food products unsound, unhealthful, unwholesome, or unfit for human food, and all such condemned meat food products shall be destroyed for food purposes, as hereinbefore provided, and the Secretary of Agriculture may remove inspectors from any establishment which fails to so de-

stroy such condemned meat food products: *Provided,* That, subject to the rules and regulations of the Secretary of Agriculture, the provisions hereof in regard to preservatives shall not apply to meat food products for export to any foreign country and which are prepared or packed according to the specifications or directions of the foreign purchaser, when no substance is used in the preparation or packing thereof in conflict with the laws of the foreign country to which said article is to be exported; but if said article shall be in fact sold or offered for sale for domestic use or consumption, then this proviso shall not exempt said article from the operation of all the other provisions of this act.

[5] That when any meat or meat food product prepared for interstate or foreign commerce which has been inspected as hereinbefore provided and marked "Inspected and Passed" shall be placed or packed in any can, pot, tin, canvas, or other receptacle or covering in any establishment where inspection under the provisions of this act is maintained, the person, firm, or corporation preparing said product shall cause a label to be attached to said can, pot, tin, canvas, or other receptacle or covering, under the supervision of an inspector, which label shall state that the contents thereof have been "Inspected and Passed" under the provisions of this act; and no inspection and examination of meat or meat food products deposited or inclosed in cans, tins, pots, canvas, or other receptacle or covering in any establishment where inspection under the provisions of this act is maintained shall be deemed to be complete until such meat or meat food products have been sealed or inclosed in said can, tin, pot, canvas, or other receptacle or covering under the supervision of an inspector, and no such meat or meat food products shall be sold or offered for sale by any person, firm, or corporation in interstate or foreign commerce under any false or deceptive name; but established trade name or names which are usual to such products and which are not false and deceptive and which shall be approved by the Secretary of Agriculture are permitted.

[6] The Secretary of Agriculture shall cause to be made, by experts in sanitation or by other competent inspectors, such inspection of all slaughtering, meat-canning, salting, packing, rendering, or similar establishments in which cattle, sheep, swine, and goats are slaughtered and the meat and meat food products thereof are prepared for interstate or foreign commerce as may be necessary to inform himself concerning the sanitary conditions of the same, and to prescribe the rules and regulations of sanitation under which such establishments shall be maintained; and where the sanitary conditions of any such establishment are such that the meat or meat food products are rendered unclean, unsound, unhealthful, unwholesome, or otherwise unfit for human food, he shall refuse to allow said meat or meat food products to be labeled, marked, stamped, or tagged as "Inspected and Passed."

[7] That the Secretary of Agriculture shall cause an examination and inspection of all cattle, sheep, swine, and goats, and the food products thereof, slaughtered and prepared in the establishments hereinbefore described for the purposes of interstate or foreign commerce to be made during the night time as well as during the daytime when the slaughtering of said cattle, sheep, swine, and goats, or the preparation of said food products is conducted during the night time.

[8] That on and after October first, nineteen hundred and six, no person, firm, or corporation shall transport or offer for transportation, and no carrier of interstate or foreign commerce shall transport or receive for transportation from one State or Territory or the District of Columbia to any other State or Territory or the District of Columbia, or to any place under the jurisdiction of the United States, or to any foreign country, any carcasses or parts thereof, meat, or meat food products thereof which have not been inspected, examined, and marked as "Inspected and Passed," in accordance with the terms of this act and with the rules and regulations prescribed by the Secretary of Agriculture: *Provided,* That all meat and meat food products on hand on October first, nineteen hundred and six, at establishments where inspection has not been maintained, or which have been inspected under existing law, shall be examined and labeled under such rules and regulations as the Secretary of Agriculture shall prescribe, and then shall be allowed to be sold in interstate or foreign commerce.

[9] That no person, firm, or corporation, or officer, agent, or employee thereof, shall forge, counterfeit, simulate, or falsely represent, or shall without proper

authority use, fail to use, or detach, or shall knowingly or wrongfully alter, deface, or destroy, or fail to deface or destroy, any of the marks, stamps, tags, labels, or other identification devices provided for in this act, or in and as directed by the rules and regulations prescribed hereunder by the Secretary of Agriculture, on any carcasses, parts of carcasses, or the food product, or containers thereof, subject to the provisions of this act, or any certificates in relation thereto, authorized or required by this act or by the said rules and regulations of the Secretary of Agriculture.

[10] That the Secretary of Agriculture shall cause to be made a careful inspection of all cattle, sheep, swine, and goats intended and offered for export to foreign countries at such times and places, and in such manner as he may deem proper, to ascertain whether such cattle, sheep, swine, and goats are free from disease.

[11] And for this purpose he may appoint inspectors who shall be authorized to give an official certificate clearly stating the condition in which such cattle, sheep, swine, and goats are found.

[12] And no clearance shall be given to any vessel having on board cattle, sheep, swine, or goats for export to a foreign country until the owner or shipper of such cattle, sheep, swine, or goats has a certificate from the inspector herein authorized to be appointed, stating that the said cattle, sheep, swine, or goats are sound and healthy, or unless the Secretary of Agriculture shall have waived the requirement of such certificate for export to the particular country to which such cattle, sheep, swine, or goats are to be exported.

[13] That the Secretary of Agriculture shall also cause to be made a careful inspection of the carcasses and parts thereof of all cattle, sheep, swine, and goats, the meat of which, fresh, salted, canned, corned, packed, cured, or otherwise prepared, is intended and offered for export to any foreign country, at such times and places and in such manner as he may deem proper.

[14] And for this purpose he may appoint inspectors who shall be authorized to give an official certificate stating the condition in which said cattle, sheep, swine, or goats, and the meat thereof, are found.

[15] And no clearance shall be given to any vessel having on board any fresh, salted, canned, corned, or packed beef, mutton, pork, or goat meat, being the meat of animals killed after the passage of this act, or except as hereinbefore provided for export to and sale in a foreign country from any port in the United States, until the owner or shipper thereof shall obtain from an inspector appointed under the provisions of this act a certificate that the said cattle, sheep, swine, and goats were sound and healthy at the time of inspection, and that their meat is sound and wholesome unless the Secretary of Agriculture shall have waived the requirements of such certificate for the country to which said cattle, sheep, swine, and goats or meats are to be exported.

[16] That the inspectors provided for herein shall be authorized to give official certificates of the sound and wholesome condition of the cattle, sheep, swine, and goats, their carcasses and products as herein described, and one copy of every certificate granted under the provisions of this act shall be filed in the Department of Agriculture, another copy shall be delivered to the owner or shipper, and when the cattle, sheep, swine, and goats or their carcasses and products are sent abroad, a third copy shall be delivered to the chief officer of the vessel on which the shipment shall be made.

[17] That no person, firm, or corporation engaged in the interstate commerce of meat or meat food products shall transport or offer for transportation, sell or offer to sell any such meat or meat food products in any State or Territory or in the District of Columbia or any place under the jurisdiction of the United States, other than in the State or Territory or in the District of Columbia or any place under the jurisdiction of the United States in which the slaughtering, packing, canning, rendering, or other similar establishment owned, leased, operated by said firm, person, or corporation is located unless and until said person, firm, or corporation shall have complied with all of the provisions of this act.

[18] That any person, firm, corporation, or any officer or agent of any such person, firm, or corporation, who shall violate any of the provisions of this act shall be deemed guilty of a misdemeanor, and shall be punished on conviction

thereof by a fine of not exceeding ten thousand dollars or imprisonment for a period of not more than two years, or by both such fine and imprisonment, in the discretion of the court.

[19] That the Secretary of Agriculture shall appoint from time to time inspectors to make examination and inspection of all cattle, sheep, swine, and goats, the inspection of which is hereby provided for, and of all carcasses and parts thereof, and of all meats and meat food products thereof, and of the sanitary conditions of all establishments in which such meat and meat food products hereinbefore described are prepared; and said inspectors shall refuse to stamp, mark, tag, or label any carcass or any part thereof, or meat food product therefrom, prepared in any establishment hereinbefore mentioned, until the same shall have actually been inspected and found to be sound, healthful, wholesome, and fit for human food, and to contain no dyes, chemicals, preservatives, or ingredients which render such meat food product unsound, unhealthful, unwholesome, or unfit for human food; and to have been prepared under proper sanitary conditions, hereinbefore provided for; and shall perform such other duties as are provided by this act and by the rules and regulations to be prescribed by said Secretary of Agriculture; and said Secretary of Agriculture shall, from time to time, make such rules and regulations as are necessary for the efficient execution of the provisions of this act, and all inspections and examinations made under this act shall be such and made in such manner as described in the rules and regulations prescribed by said Secretary of Agriculture not inconsistent with the provisions of this act.

[20] That any person, firm, or corporation, or any agent or employee of any person, firm, or corporation, who shall give, pay, or offer, directly or indirectly, to any inspector, deputy inspector, chief inspector, or any other officer or employee of the United States authorized to perform any of the duties prescribed by this act or by the rules and regulations of the Secretary of Agriculture any money or other thing of value, with intent to influence said inspector, deputy inspector, chief inspector, or other officer or employee of the United States in the discharge of any duty herein provided for, shall be deemed guilty of a felony and, upon conviction thereof, shall be punished by a fine not less than five thousand dollars nor more than ten thousand dollars and by imprisonment not less than one year nor more than three years; and any inspector, deputy inspector, chief inspector, or other officer or employee of the United States authorized to perform any of the duties prescribed by this act who shall accept any money, gift, or other thing of value from any person, firm, or corporation, or officers, agents, or employees thereof, given with intent to influence his official action, or who shall receive or accept from any person, firm, or corporation engaged in interstate or foreign commerce any gift, money, or other thing of value given with any purpose or intent whatsoever, shall be deemed guilty of a felony and shall, upon conviction thereof, be summarily discharged from office and shall be punished by a fine not less than one thousand dollars nor more than ten thousand dollars and by imprisonment not less than one year nor more than three years.

[21] That within the meaning of this act—

a) A "farmer" means any person or partnership chiefly engaged in producing agricultural products on whose farm the number of cattle, calves, sheep, lambs, swine, or goats is in keeping with the size of the farm or with the volume or character of the agricultural products produced thereon, but does not mean any person or partnership engaged in producing agricultural products who—

1) actively engages in buying or trading in cattle, calves, sheep, lambs, swine, or goats; or

2) actively engages, directly or indirectly, in conducting a business which includes the slaughter of cattle, calves, sheep, lambs, swine, or goats for food purposes; or

3) actively engages, directly or indirectly, in buying or selling meat or meat food products other than those prepared by any farmer on the farm; or

4) actively engages, directly or indirectly, in salting, curing, or canning meat, or in preparing sausage, lard, or other meat food products; or

5) slaughters, or permits any person to slaughter on his or their farm cattle, calves, sheep, lambs, swine, or goats which are not actually owned by him or them.

b) A "retail butcher" means any person, partnership, association, or corporation chiefly engaged in selling meat or meat food products to consumers only, except that the Secretary of Agriculture, at his discretion, may permit any retail butcher to transport in interstate or foreign commerce to consumers and meat retailers in any one week not more than five carcasses of cattle, twenty-five carcasses of calves, twenty carcasses of sheep, twenty-five carcasses of lambs, ten carcasses of swine, twenty carcasses of goats, or twenty-five carcasses of goat kids, or the equivalent of fresh meat therefrom, and to transport in interstate or foreign commerce to consumers only meat and meat food products which have been salted, cured, canned, or prepared as sausage, lard, or other meat food products, and which have not been inspected, examined, and marked as "Inspected and Passed" in accordance with the terms of the Meat-Inspection Act of March 4, 1907, and Acts supplemental thereto, and with the rules and regulations prescribed by the Secretary of Agriculture.

c) A "retail dealer" means any person, partnership, association, or corporation chiefly engaged in selling meat or meat food products to consumers only except that the Secretary of Agriculture, at his discretion, may permit any retail dealer to transport in interstate trade or foreign commerce to consumers and meat retailers in any one week not more than five carcasses of cattle, twenty-five carcasses of calves, twenty carcasses of sheep, twenty-five carcasses of lambs, ten carcasses of swine, twenty carcasses of goats, or twenty-five carcasses of goat kids, or the equivalent of fresh meat therefrom, and to transport in interstate or foreign commerce to consumers only meat and meat food products which have been salted, cured, canned, or prepared as sausage, lard, or other meat food products which have not been inspected, examined, and marked as "Inspected and Passed" in accordance with the terms of the Meat-Inspection Act of March 4, 1907, and Acts supplemental thereto, and with the rules and regulations prescribed by the Secretary of Agriculture.

That the provisions of the Meat-Inspection Act of March 4, 1907, requiring inspection to be made by the Secretary of Agriculture shall not apply to animals slaughtered by any farmer on the farm and sold and transported in interstate or foreign commerce, nor to retail butchers and retail dealers in meat and meat food products, supplying their customers: *Provided*, That all meat and meat food products derived from animals slaughtered by any farmer on the farm which are salted, cured, canned, or prepared into sausage, lard, or other meat food products at any place other than by the farmer on the farm upon which the animals were slaughtered shall not be transported in interstate or foreign commerce under the farmers' exemption herein provided, and all fresh meat and all farm-cured or prepared meat and meat products derived from animals slaughtered by any farmer on the farm which are to be used in interstate or foreign commerce shall be clearly marked with the name and address of the farmer on whose farm the animals were slaughtered: *Provided further*, That if any person shall sell or offer for sale or transportation for interstate or foreign commerce any meat or meat food products which are diseased, unsound, unhealthful, unwholesome, or otherwise unfit for human food, knowing that such meat food products are intended for human consumption, he shall be guilty of a misdemeanor and on conviction thereof shall be punished by a fine not exceeding $1,000 or by imprisonment for a period of not exceeding one year, or by both such fine and imprisonment: *And provided further*, That the Secretary of Agriculture is authorized to maintain the inspection in this Act provided for at any slaughtering, meat canning, salting, packing, rendering, or similar establishment notwithstanding this exception, and that the persons operating the same may be retail butchers and retail dealers or farmers: and where the Secretary of Agriculture shall establish such inspection then the provisions of this Act shall apply notwithstanding this exception.

## PUBLIC LAW 85-172
## 85TH CONGRESS, S. 1747
## AUGUST 28, 1957
## AN ACT

To provide for the compulsory inspection by the United States Department of Agriculture of poultry and poultry products.

*Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,* That this Act may be cited as the "Poultry Products Inspection Act".

### LEGISLATIVE FINDING

Sec. 2. Wholesome poultry products are an important source of the Nation's total supply of food. Such products are consumed throughout the Nation and substantial quantities thereof move in interstate and foreign commerce. Unwholesome and adulterated poultry products in the channels of interstate or foreign commerce, are injurious to the public welfare, adversely affect the marketing of wholesome poultry products, result in sundry losses to producers, and destroy markets for wholesome poultry products. The marketing of wholesome poultry products is affected with the public interest and directly affects the welfare of the people. All poultry and poultry products which have or are required to have inspection under this Act are either in the current of interstate or foreign commerce or directly affect such commerce. That part that enters directly into the current of interstate or foreign commerce cannot be effectively inspected and regulated without also inspecting and regulating all poultry and poultry products processed or handled in the same establishment.

The great volume of poultry products required as an article of food for the inhabitants of large centers of population may directly affect the movement of poultry and poultry products in interstate commerce. To protect interstate commerce in poultry and poultry products inspected for wholesomeness, from being adversely burdened, obstructed, or affected by uninspected poultry or poultry products, major consuming areas where poultry or poultry products are handled or consumed in such volume as to affect the movement of inspected poultry or poultry products in interstate commerce should be designated by the Secretary pursuant to the provisions of this Act.

### DECLARATION OF POLICY

Sec. 3. It is hereby declared to be the policy of Congress to provide for the inspection of poultry and poultry products by the inspection service as herein provided to prevent the movement in interstate or foreign commerce or in a designated major consuming area of poultry products which are unwholesome, adulterated, or otherwise unfit for human food.

### DEFINITIONS

Sec. 4. For purposes of this Act—

(*a*) The term "commerce" means commerce between any State, Territory, or possession, or the District of Columbia, and any place outside thereof; or between points within the same State or the District of Columbia, but through any place outside thereof; or within the District of Columbia.

(*b*) The term "Secretary" means the Secretary of Agriculture.

(*c*) The term "person" means any individual, partnership, corporation, association, or any other business unit.

(*d*) The term "poultry" means any live or slaughtered domesticated bird.

(*e*) The term "poultry product" means any poultry which has been slaughtered for human food from which the blood, feathers, feet, head, and viscera have been removed in accordance with rules and regulations promulgated by the Secretary, any human food product consisting of any edible part of poultry separately or in combination with other ingredients.

(*f*) The term "wholesome" means sound, healthful, clean, and otherwise fit for human food.

(*g*) The term "unwholesome" means:

(*1*) Unsound, injurious to health, or otherwise rendered unfit for human food.

(*2*) Consisting in whole or in part of any filthy, putrid, or decomposed substance.

(*3*) Processed, prepared, packed, or held under unsanitary conditions whereby a poultry carcass or parts thereof or any poultry product may have become contamin-

ated with filth or whereby a poultry product may have been rendered injurious to health.

(4) Produced in whole or in part from poultry which has died otherwise than by slaughter.

(5) Packaged in a container composed of any poisonous or deleterious substance which may render the contents injurious to health.

(h) The term "adulterated" shall apply to poultry and poultry products under one or more of the following circumstances:

(1) If they bear or contain any poisonous or deleterious substance which may render them injurious to health; but, in case the substance is not an added substance, such poultry and poultry products shall not be considered adulterated under this clause if the quantity of such substance in such poultry and poultry products does not ordinarily render them injurious to health.

(2) If they bear or contain any added poisonous or added deleterious substance, unless such substance is permitted in their production or unavoidable under good manufacturing practices as may be determined by rules and regulations hereunder prescribed by the Secretary or other provisions of Federal law limiting or tolerating the quantity of such added substance on or in such poultry and poultry products: *Provided*, That any quantity of such added substance exceeding the limits so fixed shall also be deemed to constitute adulteration.

(3) If any substance has been substituted, wholly or in part, therefor.

(4) If damage or inferiority has been concealed in any manner.

(5) If any valuable constituent has been in whole or in part omitted or abstracted therefrom.

(6) If any substance has been added thereto or mixed or packed therewith so as to increase its bulk or weight, or reduce its quality or strength, or make it appear better or of greater value than it is.

(i) The term "inspector" means: (1) an employee or official of the United States Government authorized by the Secretary to inspect poultry and poultry products under the authority of this Act, or (2) any employee or official of any State government authorized by the Secretary to inspect poultry and poultry products under authority of this Act, under an agreement entered into between the Secretary and the appropriate State agency.

(j) The term "official inspection mark" means the symbol, formulated pursuant to rules and regulations prescribed by the Secretary, stating that the product was inspected.

(k) The term "inspection service" means the official Government service within the Department of Agriculture designated by the Secretary as having the responsibility for carrying out the provisions of this Act.

(l) The terms "container" or "package" include any box, can, tin, cloth, plastic, or any other receptacle, wrapper, or cover.

(m) The term "official establishment" means any establishment as determined by the Secretary at which inspection of the slaughter of poultry, or the processing of poultry products, is maintained under the authority of this Act.

(n) The term "label" means any written, printed, or graphic material upon the shipping container, if any, or upon the immediate container, including but not limited to an individual consumer package, of the poultry product, or accompanying such product

(o) The term "shipping container" means any container used or intended for use in packaging the product packed in an immediate container.

(p) The term "immediate container" includes any consumer package; or any other container in which poultry carcasses or poultry products, not consumer packaged, are packed

as to affect, burden, or obstruct the movement of inspected poultry products in interstate commerce, the Secretary shall conduct a public hearing to ascertain whether or not it will tend to effectuate the purposes of this Act for such area to be subject to the provisons of this Act. If after public hearing the Secretary finds that poultry or poultry products are handled or consumed in such volume as to affect, burden, or obstruct the movement of inspected poultry products in commerce and that the designation of such area will tend to effectuate the purposes of this Act, he shall by order designate such area and prescribe the provisions of this Act which shall be applicable thereto and grant such exemptions therefrom as he determines practicable. Such designation shall not become effective until six months after the notice thereof is published in the Federal Register. On and after the effective date of such designation, all poultry and poultry products processed, sold, received, or delivered in any such area shall be subject to the provisions of this Act.

ANTE-MORTEM AND POST-MORTEM INSPECTION REINSPECTION, AND QUARANTINE

Sec. 6. (a) For the purpose of preventing the entry into or flow or movement in commerce or a designated major consuming area of any poultry product which is unwholesome or adulterated, the Secretary shall, where and to the extent considered by him necessary, cause to be made by inspectors ante-mortem inspection of poultry in any official establishment processing poultry or poultry products for commerce or in, or for marketing in a designated city or area.

(b) The Secretary, whenever processing operations are being conducted, shall cause to be made by inspectors post-mortem inspection of the carcass of each bird processed, and at any time such quarantine, segregation, reinspection as he deems necessary of poultry and poultry products in each official establishment processing such poultry or poultry products for commerce or in, or for marketing in a designated city or area.

(c) All poultry carcasses and parts thereof and poultry products found to be unwholesome or adulterated shall be condemned and shall, if no appeal be taken from such determination of condemnation, be destroyed for human food purposes under the supervision of an inspector: *Provided*, That carcasses, parts, and products, which may by reprocessing be made not unwholesome and not adulterated, need not be so condemned and destroyed if so reprocessed under the supervision of an inspector and thereafter found to be not unwholesome and not adulterated. If an appeal be taken from such determination, the carcasses, parts, or products shall be appropriately marked and segregated pending completion of an appeal inspection, which appeal shall be at the cost of the appellant if the Secretary determines that the appeal is frivolous. If the determination of condemnation is sustained the carcasses, parts, and products shall be destroyed for human food purposes under the supervision of an inspector.

SANITATION, FACILITIES, AND PRACTICES

Sec. 7. (a) Each official establishment slaughtering poultry or processing poultry products for commerce or in or for marketing in a designated major consuming area shall have such premises, facilities, and equipment, and be operated in accordance with such sanitary practices, as are required by regulations promulgated by the Secretary for the purpose of preventing the entry into or flow or movement in commerce or in a designated major consuming area, of poultry products which are unwholesome or adulterated.

(b) The Secretary shall refuse to render inspection to any establishment whose premises, facilities, or equipment, or the operation thereof, fail to meet the requirements of this section.

LABELING

Sec. 8. (a) Each shipping container of any poultry product inspected under the authority of this Act and found to be wholesome and not adulterated, shall at the time such product leaves the official establishment bear, in distinctly legible form, the official inspection mark and the approved plant number of the official establish-

ment in which the contents were processed. Each immediate container of any poultry product inspected under the authority of this Act and found to be wholesome and not adulterated shall at the time such product leaves the official establishment bear, in addition to the official inspection mark, in distinctly legible form, the name of the product, a statement of ingredients if fabricated from two or more ingredients including a declaration as to artificial flavors, colors, or preservatives, if any, the net weight or other appropriate measure of the contents, the name and address of the processor and the approved plant number of the official establishment in which the contents were processed. The name and address of the distributor may be used in lieu of the name and address of the processor if the approved plant number is used to identify the official establishment in which the poultry product was prepared and packed. The Secretary may permit reasonable variations and grant exemptions from the foregoing labeling requirements in any manner not in conflict with the purposes of this Act.

(*b*) The use of any written, printed or graphic matter upon or accompanying any poultry product inspected or required to be inspected pursuant to the provisions of this Act or the container thereof which is false or misleading in any particular is prohibited. No poultry products inspected or required to be inspected pursuant to the provisions of this Act shall be sold or offered for sale by any person, firm, or corporation under any false or deceptive name; but established trade name or names which are usual to such products and which are not false and deceptive and which shall be approved by the Secretary are permitted. If the Secretary has reason to believe that any label in use or prepared for use is false or misleading in any particular, he may direct that the use of the label be withheld unless it is modified in such manner as the Secretary may prescribe so that it will not be false or misleading. If the person using or proposing to use the label does not accept the determination of the Secretary, he may request a hearing, but the use of the label shall, if the Secretary so directs, be withheld pending hearing and final determination by the Secretary. Any such determination by the Secretary shall be conclusive unless within thirty days after the receipt of notice of such final determination the person adversely affected thereby appeals to the United States court of appeals for the circuit in which he has his principal place of business or to the United States Court of Appeals for the District of Columbia Circuit. The provisions of section 204 of the Packers and Stockyards Act of 1921, as amended, shall be applicable to appeals taken under this section.

PROHIBITED ACTS

Sec. 9. The following acts or the causing thereof are hereby prohibited:

(*a*) The processing, sale or offering for sale, transportation, or delivery or receiving for transportation, in commerce or in a designated major consuming area of any poultry product, unless such poultry product has been inspected for wholesomeness and unless the shipping container, if any, and the immediate container are marked in accordance with the provisions of this Act.

(*b*) The sale or other disposition for human food of any poultry or poultry product which has been inspected and declared to be unwholesome or adulterated under this Act.

(*c*) Falsely making or issuing, altering, forging, simulating, or counterfeiting any official inspection certificate, memorandum, mark, or other identification, or device for making such mark or identification, used in connection with the inspection of poultry products under this Act, or causing, procuring, aiding, assisting in, or being a party to, such false making, issuing, altering, forging, simulating, or counterfeiting, or knowingly possessing, without promptly notifying the Secretary of Agriculture or his representative, uttering, publishing, or using as true, or causing to be uttered, published, or used as true, any such falsely made or issued, altered, forged, simulated, or counterfeited official inspection certificate, memorandum, mark, or other identification, or device for making such mark or identification, or representing that any poultry or poultry product has been officially inspected under the authority of this Act when such poultry or poultry product has in fact not been so inspected.

(*d*) Using in commerce, or in a designated major consuming area, a false or misleading label on any poultry product.

(*e*) The use of any container bearing an official inspection mark except for the poultry product in the original form in which it was inspected and covered by said mark unless the mark is removed, obliterated, or otherwise destroyed.

(*f*) The refusal to permit access by any duly authorized representative of the Secretary, at all reasonable times, to the premises of an establishment engaged in processing poultry or poultry products for commerce, or in or for marketing in a designated major consuming area, upon presentation of appropriate credentials.

(*g*) The refusal to permit access to and the copying of any record as authorized by section 11 of this Act.

(*h*) The using by any person to his own advantage, or revealing, other than to the authorized representatives of the Government in their official capacity, or to the courts when relevant in any judicial proceeding under this Act, any information acquired under the authority of this Act, concerning any matter which as a trade secret is entitled to protection.

(*i*) Delivering, receiving, transporting, selling, or offering for sale or transport for human consumption any slaughtered poultry or any part thereof, separately or in combination with other ingredients (other than poultry products as defined in this Act), in commerce or from an official establishment or in a designated major consuming area, except as may be authorized by and pursuant to rules and regulations prescribed by the Secretary.

### COMPLETE COVERAGE OF OFFICIAL ESTABLISHMENTS

Sec. 10. No establishment processing poultry or poultry products for commerce or in or for marketing in a designated major consuming area shall process any poultry or poultry product except in compliance with the requirements of this Act.

### RECORDS OF INTERSTATE SHIPMENT

Sec. 11. For the purpose of enforcing the provisions of this Act, persons engaged in the business of processing, transporting, shipping, or receiving poultry slaughtered for human consumption or poultry products in commerce or in a designated major consuming area, or holding such products so received shall maintain records showing, to the extent that they are concerned therewith, the receipt, delivery, sale, movement, or disposition of poultry and poultry products and shall, upon the request of a duly authorized representative of the Secretary, permit him at reasonable times to have access to and to copy all such records. Any record required to be maintained by this section shall be maintained for a period of two years after the transaction, which is the subject of such record, has taken place.

### PENALTIES

Sec. 12. (a) Any person who violates the provisions of section 9, 10, 11, or 17, shall be guilty of a misdemeanor and shall on conviction thereof be subject to imprisonment for not more than six months, or a fine of not more than $3,000, or both such imprisonment and fine; but if such violation is committed after one conviction of such person under this section has become final such person shall be subject to imprisonment for not more than one year, or a fine of not more than $5,000, or both such imprisonment and fine; but if such violation is committed after two or more convictions of such person under this section have become final such person shall be subject to imprisonment for not more than two years, or a fine of not more than $10,000, or both such imprisonment and fine. When construing or enforcing the provisions of said sections the act, omission, or failure of any person acting for or employed by any individual, partnership, corporation, or association within the scope of his employment or office shall in every case be deemed the act, omission, or failure of such individual, partnership, corporation, or association, as well as of such person.

(*b*) No carrier shall be subject to the penalties of this Act, other than the penalties for violation of section 11, by reason of his receipt, carriage, holding, or delivery, in the usual course of business, as a carrier, of slaughtered poultry or poultry products, owned by another person unless the carrier has knowledge, or is in possession of facts which would cause a reasonable person to believe that such slaughtered poultry or poultry products were not inspected or marked in accordance with the provisions of this Act or were not otherwise eligible for transportation under this Act.

REPORTING OF VIOLATIONS

Sec. 13. Before any violation of this Act is reported by the Secretary to any United States attorney for institution of a criminal proceeding, the person against whom such proceeding is contemplated shall be given reasonable notice of the alleged violation and opportunity to present his views orally or in writing with regard to such contemplated proceeding. Nothing in this Act shall be construed as requiring the Secretary to report for criminal prosecution violations of this Act whenever he believes that the public interest will be adequately served and compliance with the Act obtained by a suitable written notice or warning.

REGULATIONS

Sec. 14. The Secretary shall promulgate such rules and regulations as are necessary to carry out the provisions of this Act.

EXEMPTIONS

Sec. 15. (a) The Secretary shall, by regulation and under such conditions as to sanitary standards, practices, and procedures as he may prescribe, exempt from specific provisions of this Act—

(*1*) poultry producers with respect to poultry of their own raising on their own farms which they sell directly to household consumers or restaurants, hotels, and boarding houses for use in their own dining rooms or in the preparation of meals for sales direct to consumers only: *Provided*, That such poultry producers do not engage in buying or selling poultry products other than those produced from poultry raised on their own farms;

(*2*) retail dealers with respect to poultry products sold directly to consumers in individual retail stores, if the only processing operation performed by such retail dealers is the cutting up of poultry products on the premises where such sales to consumers are made;

(*3*) for such period of time as the Secretary determines that it would be impracticable to provide inspection and the exemption will aid in the effective administration of this Act, any person engaged in the processing of poultry or poultry products for commerce and the poultry or poultry products processed by such person *Provided, however*, That no such exemption shall continue in effect on and after July 1, 1960, and

(*4*) persons slaughtering, processing, or otherwise handling poultry or poultry products which have been or are to be processed as required by recognized religious dietary laws, to the extent that the Secretary determines necessary to avoid conflict with such requirements while still effectuating the purposes of this Act

(*b*) The Secretary may by order suspend or terminate any exemption under this section with respect to any person whenever he finds that such action will aid in effectuating the purposes of this Act.

VIOLATIONS BY EXEMPTED PERSONS

Sec. 16. Any person who sells, delivers, transports or offers for sale or transportation in commerce or in a designated major consuming area any poultry or poultry products which are exempt under section 15, and which are unwholesome or adulter-

ated and are intended for human consumption, shall be guilty of a misdemeanor and shall on conviction thereof be subject to the penalties set forth in section 12.

### IMPORTS

Sec. 17. (a) No slaughtered poultry, or parts or products thereof, of any kind shall be imported into the United States unless they are healthful, wholesome, fit for human food, not adulterated, and contain no dye, chemical, preservative, or ingredient which renders them unhealthful, unwholesome, adulterated, or unfit for human food and unless they also comply with the rules and regulations made by the Secretary of Agriculture to assure that imported poultry or poultry products comply with the standards provided for in this Act. All imported, slaughtered poultry, or parts or products thereof, shall after entry into the United States in compliance with such rules and regulations be deemed and treated as domestic slaughtered poultry, or parts or products thereof, within the meaning and subject to the provisions of this Act and the Federal Food, Drug, and Cosmetic Act, and Acts amendatory of, supplemental to, or in substitution for such Acts.

(*b*) The Secretary of Agriculture is authorized to make rules and regulations to carry out the purposes of this section and in such rules and regulations the Secretary of Agriculture may prescribe the terms and conditions for the destruction of all slaughtered poultry, or parts or products thereof, offered for entry and refused admission into the United States unless such slaughtered poultry, or parts or products thereof, be exported by the consignee within the time fixed therefor in such rules and regulations.

(*c*) All charges for storage, cartage, and labor with respect to any product which is refused admission pursuant to this section shall be paid by the owner or consignee, and in default of such payment shall constitute a lien against any other products imported thereafter by or for such owner or consignee.

### GENERAL PROVISIONS

Sec. 18. (a) For the purpose of preventing and eliminating burdens on commerce in poultry and poultry products, the jurisdiction of the Secretary within the scope of this Act shall be exclusive and poultry and poultry products shall be exempt from the provisions of the Federal Food, Drug, and Cosmetic Act, as amended, to the extent of the application or the extension thereto of the provisions of this Act.

(b) In carrying out the provisions of this Act, the Secretary may cooperate with other branches of Government and with State agencies and may conduct such examinations, investigations, and inspections as he determines practicable through any officer or employee of a State commissioned by the Secretary for such purpose.

### COST OF INSPECTION

Sec. 19. The cost of inspection rendered under the requirements of this Act, shall be borne by the United States, except that the cost of overtime and holiday work performed in establishments subject to the provisions of this Act at such rates as the Secretary may determine shall be borne by such establishments. Sums received by the Secretary in reimbursement for sums paid out by him for such premium pay work shall be available without fiscal year limitation to carry out the purposes of this section.

application of such provision to other persons and circumstances shall not be affected thereby.

###### EFFECTIVE DATE

Sec. 22. This Act shall take effect upon enactment, except that no person shall be subject to the provisions of this Act prior to January 1, 1959, unless such person after January 1, 1958, applies for an receives inspection for poultry or poultry products in accordance with the provisions of this Act and pursuant to regulations promulgated by the Secretary hereunder, in any establishment processing poultry or poultry products in commerce or in a designated major consuming area. Any person who voluntarily applies for and receives such inspection after January 1, 1958, shall be subject, on and after the date he commences to receive such inspection, to all of the provisions and penalties provided for in this Act with respect to all poultry or poultry products handled in the establishment for which such said application for inspection is made.

Approved August 28, 1957.

## DEPARTMENT OF HEALTH EDUCATION AND WELFARE

### Food and Drug Administration

## *FEDERAL FOOD, DRUG, AND COSMETIC ACT AND GENERAL REGULATIONS FOR ITS ENFORCEMENT*

### PUBLIC—NO. 717—SEVENTY-FIFTH CONGRESS, CHAPTER 675, THIRD SESSION, S. 5

### AN ACT

To prohibit the movement in interstate commerce of adulterated and misbranded food, drugs, devices, and cosmetics, and for other purposes.

*Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,*

### CHAPTER I—SHORT TITLE

Section 1. This Act may be cited as the Federal Food, Drug, and Cosmetic Act.

### CHAPTER II—DEFINITIONS

### CHAPTER III—PROHIBITED ACTS AND PENALTIES

###### PROHIBITED ACTS

Sec. 301. The following acts and the causing thereof are hereby prohibited:

*a*) The introduction or delivery for introduction into interstate commerce of any food, drug, device, or cosmetic that is adulterated or misbranded.

*b*) The adulteration or misbranding of any food, drug, device, or cosmetic in interstate commerce.

*c*) The receipt in interstate commerce of any food, drug, device, or cosmetic that is adulterated or misbranded, and the delivery or proffered delivery thereof for pay or otherwise.

*d*) The introduction or delivery for introduction into interstate commerce of any article in violation of section 404 or 505.

*e*) The refusal to permit access to or copying of any record as required by section 703.

*f*) The refusal to permit entry or inspection as authorized by section 704.

*g*) The manufacture within any Territory of any food, drug, device, or cosmetic that is adulterated or misbranded

*h*) The giving of a guaranty or undertaking referred to in section 303 (*c*) (2), which guaranty or undertaking is false, except by a person who relied upon a guaranty or undertaking to the same effect signed by, and containing the name and address of, the person residing in the United States from whom he received in good faith the food, drug, device, or cosmetic; or the giving of a guaranty or undertaking referred to in section 303 (*c*) (3), which guaranty or undertaking is false.

*Regulation.* [§ 1.4] In case of the giving of a guaranty or undertaking referred to in section 303 (*c*) (2) or (3) of the Act, each person signing such guaranty or undertaking shall be considered to have given it.

[SEC. 301. The following acts and the causing thereof are hereby prohibited:

*i*) Forging, counterfeiting, simulating, or falsely representing, or without proper authority using any mark, stamp, tag, label, or other identification device authorized or required by regulations promulgated under the provisions of section 404, 406 (*b*), 504, 506, 507, or 604.

*j*) The using by any person to his own advantage, or revealing, other than to the Administrator or officers or employees of the Agency, or to the courts when relevant in any judicial proceeding under this Act, any information acquired under authority of section 404, 505, 506, 507, or 704 concerning any method or process which as a trade secret is entitled to protection.

*k*) The alteration, mutilation, destruction, obliteration, or removal of the whole or any part of the labeling of, or the doing of any other act with respect to, a food, drug, device, or cosmetic, if such act is done while such article is held for sale (whether or not the first sale) after shipment in interstate commerce and results in such article being adulterated or misbranded.

*l*) The using, on the labeling of any drug or in any advertising relating to such drug, of any representation or suggestion that an application with respect to such drug is effective under section 505, or that such drug complies with the provisions of such section.

### INJUNCTION PROCEEDINGS

SEC. 302. (*a*) The district courts of the United States and the United States courts of the Territories shall have jurisdiction, for cause shown, and subject to the provisions of section 17 (relating to notice to opposite party) of the Act entitled "An Act to supplement existing laws against unlawful restraints and monopolies, and for other purposes," approved October 15, 1914, as amended (U. S. C., 1934 ed., title 28, sec. 381), to restrain violations of section 301, except paragraphs (*e*), (*f*), (*h*), (*i*), and (*j*).

*b*) In case of violation of an injunction or restraining order issued under this section, which also constitutes a violation of this Act, trial shall be by the court, or, upon demand of the accused, by a jury. Such trial shall be conducted in accordance with the practice and procedure applicable in the case of proceedings subject to the provisions of section 22 of such Act of October 15, 1914, as amended (U. S. C., 1934 ed., title 28, sec. 387).

### PENALTIES

SEC. 303. (*a*) Any person who violates any of the provisions of section 301 shall be guilty of a misdemeanor and shall on conviction thereof be subject to imprisonment for not more than one year, or a fine of not more than $1,000, or both such imprisonment and fine; but if the violation is committed after a conviction of such person under this section has become final such person shall be subject to imprisonment for not more than three years, or a fine of not more than $10,000, or both such imprisonment and fine.

*b*) Notwithstanding the provisions of subsection (*a*) of this section, in case of a violation of any of the provisions of section 301, with intent to defraud or mislead, the penalty shall be imprisonment for not more than three years, or a fine of not more than $10,000, or both such imprisonment and fine.

*c*) No person shall be subject to the penalties of subsection (*a*) of this section, (1) for having received in interstate commerce any article and delivered it or prof-

fered delivery of it, if such delivery or proffer was made in good faith, unless he refuses to furnish on request of an officer or employee duly designated by the Administrator the name and address of the person from whom he purchased or received such article and copies of all documents, if any there be, pertaining to the delivery of the article to him; or (2) for having violated section 301 (*a*) or (*d*), if he establishes a guaranty or undertaking signed by, and containing the name and address of, the person residing in the United States from whom he received in good faith the article, to the effect, in case of an alleged violation of section 301 (*a*), that such article is not adulterated or misbranded, within the meaning of this Act, designating this Act, or to the effect, in case of an alleged violation of section 301 (*d*), that such article is not an article which may not, under the provisions of section 404 or 505, be introduced into interstate commerce; or (3) for having violated section 301 (*a*), where the violation exists because the article is adulterated by reason of containing a coal-tar color not from a batch certified in accordance with regulations promulgated by the Administrator under this Act, if such person establishes a guaranty or undertaking signed by, and containing the name and address of, the manufacturer of the coal-tar color, to the effect that such color was from a batch certified in accordance with the applicable regulations promulgated by the Administrator under this Act.

*Regulation.* [§ 1.5] (a) A guaranty or undertaking referred to in section 303 (*c*) (2) of the Act may be:

1) limited to a specific shipment or other delivery of an article, in which case it may be a part of or attached to the invoice or bill of sale covering such shipment or delivery, or
2) general and continuing, in which case, in its application to any shipment or other delivery of an article, it shall be considered to have been given at the date such article was shipped or delivered by the person who gives the guaranty or undertaking.

*b*) The following are suggested forms of guaranty or undertaking under section 303 (*c*) (2) of the Act:

1) *Limited Form for use on invoice or bill of sale.*

(Name of person giving the guaranty or undertaking) hereby guarantees that no article listed herein is adulterated or misbranded within the meaning of the Federal Food, Drug, and Cosmetic Act, or is an article which may not, under the provisions of section 404 or 505 of the Act, be introduced into interstate commerce.

(Signature and post-office address of person giving the guaranty or undertaking.)

manufacturer, such guaranty or undertaking shall be signed by such manufacturer and by an agent of such manufacturer who resides in the United States.

*e*) The following are suggested forms of guaranty or undertaking under section 303 (*c*) (3) of the Act:

1) For domestic manufacturers.

(Name of manufacturer) hereby guarantees that all coal-tar colors listed herein were manufactured by him, and are from batches certified in accordance with the applicable regulations promulgated under the Federal Food, Drug, and Cosmetic Act.

(Signature and post-office address of manufacturer.)

2) For foreign manufacturers.

(Name of manufacturer and agent) hereby severally guarantee that all coal-tar colors listed herein were manufactured by (name of manufacturer), and are from batches certified in accordance with the applicable regulations promulgated under the Federal Food, Drug, and Cosmetic Act.

(Signature and post-office address of manufacturer.)

(Signature and post-office address of agent.)

*f*) For the purpose of a guaranty or undertaking under section 303 (*c*) (3) of the Act the manufacturer of a shipment or other delivery of a coal-tar color is the person who packaged such color.

*g*) A guaranty or undertaking, if signed by two or more persons, shall state that such persons severally guarantee the article to which it applies.

*h*) No representation or suggestion that an article is guaranteed under the Act shall be made in labeling.

### SEIZURE

SEC. 304. (*a*) Any article of food, drug, device, or cosmetic that is adulterated or misbranded when introduced into or while in interstate commerce or while held for sale (whether or not the first sale) after shipment in interstate commerce, or which may not, under the provisions of section 404 or 505, be introduced into interstate commerce, shall be liable to be proceeded against while in interstate commerce, or at anytime thereafter, on libel of information and condemned in any district court of the United States within the jurisdiction of which the article is found: *Provided, however,* That no libel for condemnation shall be instituted under this Act, for any alleged misbranding if there is pending in any court a libel for condemnation proceeding under this Act based upon the same alleged misbranding, and not more than one such proceeding shall be instituted if no such proceeding is so pending, except that such limitations shall not apply (1) when such misbranding has been the basis of a prior judgment in favor of the United States, in a criminal, injunction, or libel for condemnation proceeding under this Act, or (2) when the Administrator has probable cause to believe from facts found, without hearing, by him or any officer or employee of the Agency that the misbranded article is dangerous to health, or that the labeling of the misbranded article is fraudulent, or would be in a material respect misleading to the injury or damage of the purchaser or consumer. In any case where the number of libel for condemnation proceedings is limited as above provided the proceeding pending or instituted shall, on application of the claimant, seasonably made, be removed for trial to any district agreed upon by stipulation between the parties, or, in case of failure to so stipulate within a reasonable time, the claimant may apply to the court of the district in which the seizure has been made, and such court (after giving the United States attorney for such district reasonable notice and opportunity to be heard) shall by order, unless good cause to the contrary is shown, specify a district of reasonable proximity to the claimant's principal place of business to which the case shall be removed for trial.

*b*) The article shall be liable to seizure by process pursuant to the libel, and the procedure in cases under this section shall conform, as nearly as may be, to the procedure in admiralty; except that on demand of either party any issue of fact joined in any such case shall be tried by jury. When libel for condemnation proceedings under this section, involving the same claimant and the same issues of adulteration or misbranding, are pending in two or more jurisdictions, such

pending proceedings, upon application of the claimant seasonably made to the court of one such jurisdiction, shall be consolidated for trial by order of such court, and tried in (1) any district selected by the claimant where one of such proceedings is pending; or (2) a district agreed upon by stipulation between the parties. If no order for consolidation is so made within a reasonable time, the claimant may apply to the court of one such jurisdiction, and such court (after giving the United States attorney for such district reasonable notice and opportunity to be heard) shall by order, unless good cause to the contrary is shown, specify a district of reasonable proximity to the claimant's principal place of business, in which all such pending proceedings shall be consolidated for trial and tried. Such order of consolidation shall not apply so as to require the removal of any case the date for trial of which has been fixed. The court granting such order shall give prompt notification thereof to the other courts having jurisdiction of the cases covered thereby.

c) The court at any time after seizure up to a reasonable time before trial shall by order allow any party to a condemnation proceeding, his attorney or agent, to obtain a representative sample of the article seized, and as regards fresh fruits or fresh vegetables, a true copy of the analysis on which the proceeding is based and the identifying marks or numbers, if any, of the packages from which the samples analyzed were obtained.

d) Any food, drug, device, or cosmetic condemned under this section shall, after entry of the decree, be disposed of by destruction or sale as the court may, in accordance with the provisions of this section, direct and the proceeds thereof, if sold, less the legal costs and charges, shall be paid into the Treasury of the United States; but such article shall not be sold under such decree contrary to the provisions of this Act or the laws of the jurisdiction in which sold: *Provided*, That after entry of the decree and upon the payment of the costs of such proceedings and the execution of a good and sufficient bond conditioned that such article shall not be sold or disposed of contrary to the provisions of this Act or the laws of any State or Territory in which sold, the court may by order direct that such article be delivered to the owner thereof to be destroyed or brought into compliance with the provisions of this Act under the supervision of an officer or employee duly designated by the Administrator, and the expenses of such supervision shall be paid by the person obtaining release of the article under bond. Any article condemned by reason of its being an article which may not, under section 404 or 505, be introduced into interstate commerce, shall be disposed of by destruction.

e) When a decree of condemnation is entered against the article, court costs and fees, and storage and other proper expenses, shall be awarded against the person, if any, intervening as claimant of the article.

f) In the case of removal for trial of any case as provided by subsection (*a*) or (*b*)—

In case such person holds a guaranty or undertaking referred to in section 303 (*c*) (2) or (3) of the Act applicable to the article on which such notice was based, such guaranty or undertaking, or a verified copy thereof, shall be made a part of such presentation of views.

*b*) Upon request, seasonably made, by the person to whom a notice appointing a time and place for the presentation of views under section 305 of the Act has been given, or by his representative, such time or place, or both such time and place, may be changed if the request states reasonable grounds therefor. Such request shall be addressed to the office of the Food and Drug Administration which issued the notice.

### REPORT OF MINOR VIOLATIONS

SEC. 306. Nothing in this Act shall be construed as requiring the Administrator to report for prosecution, or for the institution of libel or injunction proceedings, minor violations of this Act whenever he believes that the public interest will be adequately served by a suitable written notice or warning.

### PROCEEDINGS IN NAME OF UNITED STATES; PROVISION AS TO SUBPENAS

SEC. 307. All such proceedings for the enforcement, or to restrain violations, of this Act shall be by and in the name of the United States. Notwithstanding the provisions of section 876 of the Revised Statutes, subpenas for witnesses who are required to attend a court of the United States, in any district, may run into any other district in any such proceeding.

## CHAPTER IV—FOOD

### DEFINITIONS AND STANDARDS FOR FOOD

SEC. 401. Whenever in the judgment of the Administrator such action will promote honesty and fair dealing in the interest of consumers, he shall promulgate regulations fixing and establishing for any food, under its common or usual name so far as practicable, a reasonable definition and standard of identity, a reasonable standard of quality, and/or reasonable standards of fill of container: *Provided*, That no definition and standard of identity and no standard of quality shall be established for fresh or dried fruits, fresh or dried vegetables, or butter, except that definitions and standards of identity may be established for avocadoes, cantaloupes, citrus fruits, and melons. In prescribing any standard of fill of container, the Administrator shall give due consideration to the natural shrinkage in storage and in transit of fresh natural food and to need for the necessary packing and protective material. In the prescribing of any standard of quality for any canned fruit or canned vegetable, consideration shall be given and due allowance made for the differing characteristics of the several varieties of such fruit or vegetable. In prescribing a definition and standard of identity for any food or class of food in which optional ingredients are permitted, the Administrator shall, for the purpose of promoting honesty and fair dealing in the interest of consumers, designate the optional ingredients which shall be named on the label. Any definition and standard of identity prescribed by the Administrator for avocadoes, cantaloupes, citrus fruits, or melons shall relate only to maturity and to the effects of freezing.

### ADULTERATED FOOD

SEC. 402. A food shall be deemed to be adulterated—

*a*) (1) If it bears or contains any poisonous or deleterious substance which may render it injurious to health; but in case the substance is not an added substance such food shall not be considered adulterated under this clause if the quantity of such substance in such food does not ordinarily render it injurious to health; or (2) if it bears or contains any added poisonous or added deleterious substance which is unsafe within the meaning of section 406; or (3) if it consists in whole or in part of any filthy, putrid, or decomposed substance, or if it is otherwise unfit

for food; or (4) if it has been prepared, packed, or held under insanitary conditions whereby it may have become contaminated with filth, or whereby it may have been rendered injurious to health; or (5) if it is, in whole or in part, the product of a diseased animal or of an animal which has died otherwise than by slaughter; or (6) if its container is composed, in whole or in part, of any poisonous or deleterious substance which may render the contents injurious to health.

*b*) (1) If any valuable constituent has been in whole or in part omitted or abstracted therefrom; or (2) if any substance has been substituted wholly or in part therefor; or (3) if damage or inferiority has been concealed in any manner; or (4) if any substance has been added thereto or mixed or packed therewith so as to increase its bulk or weight, or reduce its quality or strength, or make it appear better or of greater value than it is.

*c*) If it bears or contains a coal-tar color other than one from a batch that has been certified in accordance with regulations as provided by section 406: *Provided*, That this paragraph shall not apply to citrus fruit bearing or containing a coal-tar color if application for listing of such color has been made under this Act and such application has not been acted on by the Administrator, if such color was commonly used prior to the enactment of this Act for the purpose of coloring citrus fruit.

*d*) If it is confectionery, and it bears or contains any alcohol or nonnutritive article or substance except harmless coloring, harmless flavoring, harmless resinous glaze not in excess of four-tenths of 1 per centum, natural gum, and pectin: *Provided*, That this paragraph shall not apply to any confectionery by reason of its containing less than one-half of 1 per centum by volume of alcohol derived solely from the use of flavoring extracts, or to any chewing gum by reason of its containing harmless nonnutritive masticatory substances.

in lieu of the actual place where each package of such food was manufactured or packed or is to be distributed, if such statement is not misleading in any particular.

*d*) The requirement that the label shall contain the name and place of business of the manufacturer, packer, or distributor shall not be considered to relieve any food from the requirement that its label shall not be misleading in any particular.

*e*) (1) The statement of the quantity of the contents shall reveal the quantity of food in the package, exclusive of wrappers and other material packed with such food.

(2) The statement shall be expressed in the terms of weight, measure, numerical count, or a combination of numerical count and weight or measure which are generally used by consumers to express quantity of such food and which give accurate information as to the quantity thereof. But if no general consumer usage in expressing accurate information as to the quantity of such food exists, the statement shall be in terms of liquid measure if the food is liquid, or in terms of weight if the food is solid, semisolid, viscous, or a mixture of solid and liquid; except that such statement may be in terms of dry measure if the food is a fresh fruit, fresh vegetable, or other dry commodity.

*f*) (1) A statement of weight shall be in terms of the avoirdupois pound and ounce. A statement of liquid measure shall be in terms of the United States gallon of 231 cubic inches and quart, pint, and fluid ounce subdivisions thereof, and, except in case of frozen food which is so consumed, shall express the volume at 68° Fahrenheit (20° Centigrade). A statement of dry measure shall be in terms of the United States bushel of 2150.42 cubic inches and peck, dry quart, and dry pint subdivisions thereof; or in terms of the United States standard barrel and its subdivisions of third, half, and three-quarters barrel. However, in the case of an export shipment, the statement may be in terms of a system of weight or measure in common use in the country to which such shipment is exported.

(2) A statement of weight or measure in the terms specified in subparagraph (1) of this paragraph may be supplemented by a statement in terms of the metric system of weight or measure.

(3) Unless an unqualified statement of numerical count gives accurate information as to the quantity of food in the package, it shall be supplemented by such statement of weight, measure, or size of the individual units of the food as will give such information.

*g*) Statements shall contain only such fractions as are generally used in expressing the quantity of the food. A common fraction shall be reduced to its lowest terms; a decimal fraction shall not be carried out to more than two places.

*h*) (1) If the quantity of food in the package equals or exceeds the smallest unit of weight or measure which is specified in paragraph (*f*) of this section, and which is applicable to such food under the provisions of paragraph (*e*) (2) of this section, the statement shall express the number of the largest of such units contained in the package (for example, the statement on the label of a package which contains one quart of food shall be "1 quart," and not "2 pints" or "32 fluid ounces"), unless the statement is made in accordance with the provisions of subparagraph (2) of this paragraph. Where such number is a whole number and a fraction, there may be substituted for the fraction its equivalent in smaller units, if any smaller is specified in such paragraph (*f*) (for examples, 1¾ quarts may be expressed as "1 quart 1½ pints" or "1 quart 1 pint 8 fluid ounces;" 1¼ pounds may be expressed as "1 pound 4 ounces"). The stated number of any unit which is smaller than the largest unit (specified in such paragraph (*f*) contained in the package shall not equal or exceed the number of such smaller units in the next larger unit so specified (for examples, instead of "1 quart 16 fluid ounces" the statement shall be "1½ quarts" or "1 quart 1 pint"; instead of "24 ounces" the statement shall be "1½ pounds" or "1 pound 8 ounces").

2) In the case of a food with respect to which there exists an established custom of stating the quantity of the contents as a fraction of a unit, which unit is larger than the quantity contained in the package, or as units smaller than the largest unit contained therein, the statement may be made in accordance with such custom if it is informative to consumers.

*i*) The statement shall express the minimum quantity or the average quantity, f the contents of the packages. If the statement is not so qualified as to show efinitely that the quantity expressed is the minimum quantity, the statement hall be considered to express the average quantity.

*j*) Where the statement expresses the minimum quantity, no variation below he stated minimum shall be permitted except variations below the stated weight or measure caused by ordinary and customary exposure, after the food is introluced into interstate commerce, to conditions which normally occur in good distribution practice and which unavoidably result in decreased weight or measure. Variations above the stated minimum shall not be unreasonably large.

*k*) Where the statement does not express the minimum quantity:

1) variations from the stated weight or measure shall be permitted when caused by ordinary and customary exposure, after the food is introduced into interstate commerce, to conditions which normally occur in good distribution practice and which unavoidably result in change of weight or measure;
2) variations from the stated weight, measure, or numerical count shall be permitted when caused by unavoidable deviations in weighing, measuring, or counting individual packages which occur in good packing practice. But under subparagraph (2) of this paragraph variations shall not be permitted to such extent that the average of the quantities in the packages comprising a shipment or other delivery of the food is below the quantity stated, and no unreasonable shortage in any package shall be permitted, even though overages in other packages in the same shipment or delivery compensate for such shortage.

*l*) The extent of variations from the stated quantity of the contents permissible under paragraphs (*j*) and (*k*) of this section in the case of each shipment or other delivery shall be determined by the facts in such case.

*m*) A food shall be exempt from compliance with the requirements of clause (2) of section 403 (*e*) of the Act if:

1) The quantity of the contents, as expressed in terms applicable to such food under the provisions of paragraph (*e*) (2) of this section, is less than one-half ounce avoirdupois, or less than one-half fluid ounce, or (in case the units of the food can be easily counted without opening the package) less than six units, or
2) The statement of the quantity of the contents of the package, together with all other words, statements, and information required by or under authority of the Act to appear on the label, cannot, because of insufficient label space, be so placed on the label as to comply with the requirements of section 403 (*f*) of the Act and regulations promulgated thereunder.

*f*) If any word, statement, or other information required by or under authority of this Act to appear on the label or labeling is not prominently placed thereon with such conspicuousness (as compared with other words, statements, designs, or devices, in the labeling) and in such terms as to render it likely to be read and understood by the ordinary individual under customary conditions of purchase and use

*Regulation* [§ 1.9] (*a*) A word, statement, or other information required by or under authority of the Act to appear on the label may lack that prominence and conspicuousness required by section 403 (*f*) of the Act by reason (among other reasons) of

1) The failure of such word, statement, or information to appear on the part or panel of the label which is presented or displayed under customary conditions of purchase,
2) The failure of such word, statement, or information to appear on two or more parts or panels of the label, each of which has sufficient space therefor,

and each of which is so designed as to render it likely to be, under customary conditions of purchase, the part or panel displayed;

3) The failure of the label to extend over the area of the container or package available for such extension, so as to provide sufficient label space for the prominent placing of such word, statement, or information;

4) Insufficiency of label space (for the prominent placing of such word, statement, or information) resulting from the use of label space for any word, statement, design, or device which is not required by or under authority of the Act to appear on the label;

5) Insufficiency of label space (for the prominent placing of such word, statement, or information) resulting from the use of label space to give materially greater conspicuousness to any other word, statement, or information, or to any design or device; or

6) Smallness or style of type in which such word, statement, or information appears, insufficient background contrast, obscuring designs or vignettes, or crowding with other written, printed, or graphic matter.

*b*) No exemption depending on insufficiency of label space, as prescribed in regulations promulgated under section 403 (*e*) or (*i*) of the Act, shall apply if such insufficiency is caused by:

1) The use of label space for any word, statement, design, or device which is not required by or under authority of the Act to appear on the label;

2) The use of label space, to give greater conspicuousness to any word, statement, or other information than is required by section 403 (*f*) of the Act; or

3) The use of label space for any representation in a foreign language.

*c*) (1) All words, statements, and other information required by or under authority of the Act to appear on the label or labeling shall appear thereon in the English language.

2) If the label contains any representation in a foreign language, all words, statements, and other information required by or under authority of the Act to appear on the label shall appear thereon in the foreign language.

3) If the labeling contains any representation in a foreign language, all words, statements, and other information required by or under authority of the Act to appear on the label or labeling shall appear on the labeling in the foreign language.

*g*) If it purports to be or is represented as a food for which a definition and standard of identity has been prescribed by regulations as provided by section 401, unless (1) it conforms to such definition and standard, and (2) its label bears the name of the food specified in the definition and standard, and, insofar as may be required by such regulations, the common names of optional ingredients (other than spices, flavoring, and coloring) present in such food.

*Regulation.* [§ 1.14] In the following conditions, among others, a food does not conform to the definition and standard of identity therefor:

*a*) If it contains an ingredient for which no provision is made in such definition and standard;

*b*) If it fails to contain any one or more ingredients required by such definition

each such ingredient; except that spices, flavorings, and colorings, other than those sold as such, may be designated as spices, flavorings, and colorings without naming each: *Provided*, That to the extent that compliance with the requirements of clause (2) of this paragraph is impracticable, or results in deception or unfair competition, exemptions shall be established by regulations promulgated by the Administrator.

*Regulation.* [§ 1.10] (*a*) The name of an ingredient (except a spice, flavoring, or coloring which is an ingredient of a food other than one sold as a spice, flavoring, or coloring), required by section 403 (*i*) (2) of the Act to be borne on the label of a food, shall be a specific name and not a collective name. But if an ingredient (which itself contains two or more ingredients) conforms to a definition and standard of identity prescribed by regulations under section 401 of the Act, such ingredient may be designated on the label of such food by the name specified in the definition and standard, supplemented, in case such regulations require the naming of optional ingredients present in such ingredient, by a statement showing the optional ingredients which are present in such ingredient.

*b*) No ingredient shall be designated on the label as a spice, flavoring, or coloring unless it is a spice, flavoring, or coloring, as the case may be, within the meaning of such term as commonly understood by consumers. The term "coloring" shall not include any bleaching substance.

*c*) An ingredient which is both a spice and a coloring, or both a flavoring and a coloring, shall be designated as spice and coloring, or flavoring and coloring, as the case may be, unless such ingredient is designated by its specific name.

*d*) A label may be misleading by reason (among other reasons) of:

1) The order in which the names of ingredients appear thereon, or the relative prominence otherwise given such names; or

2) Its failure to reveal the proportion of, or other fact with respect to, an ingredient, when such proportion or other fact is material in the light of the representation that such ingredient was used in fabricating the food.

*e*) (1) A food shall be exempt from the requirements of clause (2) of section 403 (*i*) of the Act if all words, statements, and other information required by or under authority of the Act to appear on the label of such food, cannot, because of insufficient label space, be so placed on the label as to comply with the requirements of section 403 (*f*) of the Act and regulations promulgated thereunder. But such exemption shall be on the condition that, if the omission from the label of the statement of the quantity of the contents affords sufficient space to state legibly thereon all the information required by such clause (2), such statement of the quantity of the contents shall be omitted as authorized by § 1.9 (*m*) (2), and the information required by such clause (2) shall be so stated as prominently as practicable even though the statement is not of such conspicuousness as to render it likely to be read by the ordinary individual under customary conditions of purchase.

2) In the case of an assortment of different items of food, when variations in the items which make up different packages packed from such assortment normally occur in good packing practice, and when such variations result in variations in the ingredients in different packages, such food shall be exempt from compliance with the requirements of clause (2) of section 403 (i) of the Act with respect to any ingredient which is not common to all packages. But such exemption shall be on the condition that the label shall bear, in conjunction with the names of such ingredients as are common to all packages, a statement in terms which are as informative as practicable and which are not misleading, indicating that other ingredients may be present.

*j*) If it purports to be or is represented for special dietary uses, unless its label bears such information concerning its vitamin, mineral, and other dietary properties as the Administrator determines to be, and by regulations prescribes as, necessary in order fully to inform purchasers as to its value for such uses.

*Regulation.* [§ 1.11] (*a*) The term "special dietary uses," as applied to food for man, means particular (as distinguished from general) uses of food, as follows:

1) Uses for supplying particular dietary needs which exist by reason of a physical, physiological, pathological or other condition, including but not limited to the conditions of disease, convalescence, pregnancy, lactation, allergic hypersensitivity to food, underweight, and overweight;
2) Uses for supplying particular dietary needs which exist by reason of age, including but not limited to the ages of infancy and childhood;
3) Uses for supplementing or fortifying the ordinary or usual diet with any vitamin, mineral, or other dietary property. Any such particular use of a food is a special dietary use, regardless of whether such food also purports to be or is represented for general use.

*b*) No provision of any regulation under section 403 (*j*) of the Act shall be construed as exempting any food from any other provision of the Act or regulations thereunder, including sections 403 (*a*) and (*g*) and, when applicable, the provisions of Chapter V.

*k*) If it bears or contains any artificial flavoring, artificial coloring, or chemical preservative, unless it bears labeling stating that fact: *Provided*, That to the extent that compliance with the requirements of this paragraph is impracticable, exemptions shall be established by regulations promulgated by the Administrator. The provisions of this paragraph and paragraphs (*g*) and (*i*) with respect to artificial coloring shall not apply in the case of butter, cheese, or ice cream.

*Regulation.* [§ 1.12] (*a*) (1) The term "artificial flavoring" means a flavoring containing any sapid or aromatic constituent, which constituent was manufactured by a process of synthesis or other similar artifice.

2) The term "artificial coloring" means a coloring containing any dye or pigment, which dye or pigment was manufactured by a process of synthesis or other similar artifice, or a coloring which was manufactured by extracting a natural dye or natural pigment from a plant or other material in which such dye or pigment was naturally produced.
3) The term "chemical preservative" means any chemical which, when added to food, tends to prevent or retard deterioration thereof; but does not include common salt, sugars, vinegars, spices or oils extracted from spices, or substances added to food by direct exposure thereof to wood smoke.

*b*) A food which is subject to the requirements of section 403 (*k*) of the Act shall bear labeling, even though such food is not in package form.

*c*) A statement of artificial flavoring, artificial coloring, or chemical preservative shall be placed on the food, or on its container or wrapper, or on any two or all of these, as may be necessary to render such statement likely to be read by the ordinary individual under customary conditions of purchase and use of such food.

*d*) A food shall be exempt from compliance with the requirements of section 403 (*k*) of the Act if it is not in package form and the units thereof are so small that a statement of artificial flavoring, artificial coloring, or chemical preservative, as the case may be, cannot be placed on such units with such conspicuousness as to render it likely to be read by the ordinary individual under customary conditions of purchase and use.

EMERGENCY PERMIT CONTROL

Sec. 404. (*a*) Whenever the Administrator finds after investigation that the distribution in interstate commerce of any class of food may, by reason of contamination with micro-organisms during the manufacture, processing, or packing thereof in any locality, be injurious to health, and that such injurious nature cannot be adequately determined after such articles have entered interstate commerce, he then, and in such case only, shall promulgate regulations providing for the issuance, to manufacturers, processors, or packers of such class of food in such locality, of permits to which shall be attached such conditions governing the manufacture, processing, or packing of such class of food, for such temporary period of time, as may be necessary to protect the public health; and after the effective date of such regulations, and during such temporary period, no person shall introduce or deliver for introduction into interstate commerce any such food manufactured, processed, or packed by any such manufacturer, processor, or packer

unless such manufacturer, processor, or packer holds a permit issued by the Administrator as provided by such regulations.

*b*) The Administrator is authorized to suspend immediately upon notice any permit issued under authority of this section if it is found that any of the conditions of the permit have been violated. The holder of a permit so suspended shall be privileged at any time to apply for the reinstatement of such permit, and the Administrator shall, immediately after prompt hearing and an inspection of the establishment, reinstate such permit if it is found that adequate measures have been taken to comply with and maintain the conditions of the permit, as originally issued or as amended.

*c*) Any officer or employee duly designated by the Administrator shall have access to any factory or establishment, the operator of which holds a permit from the Administrator, for the purpose of ascertaining whether or not the conditions of the permit are being complied with, and denial of access for such inspection shall be ground for suspension of the permit until such access is freely given by the operator.

#### REGULATIONS MAKING EXEMPTIONS

SEC. 405. The Administrator shall promulgate regulations exempting from any labeling requirement of this Act (1) small open containers of fresh fruits and fresh vegetables and (2) food which is, in accordance with the practice of the trade, to be processed, labeled, or repacked in substantial quantities at establishments other than those where originally processed or packed, on condition that such food is not adulterated or misbranded under the provisions of this Act upon removal from such processing, labeling, or repacking establishment.

*Regulation.* [§ 1.13] (*a*) (1) An open container is a container of rigid or semi-rigid construction, which is not closed by lid, wrapper, or otherwise.

2) An open container of a fresh fruit or fresh vegetable, the quantity of contents of which is not more than one dry quart, shall be exempt from the labeling requirements of paragraphs (*e*), (*g*) (2) (with respect to the name of the food specified in the definition and standard), and (*i*) (1) of section 403 of the Act; but such exemption shall be on the condition that if two or more such containers are enclosed in a crate or other shipping package, such crate or package shall bear labeling showing the number of such containers enclosed therein and the quantity of the contents of each.

*b*) Except as provided by paragraphs (*c*) and (*d*) of this section, a shipment or other delivery of a food which is, in accordance with the practice of the trade, to be processed, labeled, or repacked in substantial quantity at an establishment other than that where originally processed or packed, shall be exempt, during the time of introduction into and movement in interstate commerce and the time of holding in such establishment, from compliance with the labeling requirements of section 403 (*c*), (*e*), (*g*), (*h*), (*i*), (*j*) and (*k*) of the Act if:

1) The person who introduced such shipment or delivery into interstate commerce is the operator of the establishment where such food is to be processed, labeled, or repacked; or

2) In case such person is not such operator, such shipment or delivery is made to such establishment under a written agreement, signed by and containing the post-office addresses of such person and such operator, and containing such specifications for the processing, labeling, or repacking, as the case may be, of such food in such establishment as will insure, if such specifications are followed, that such food will not be adulterated or misbranded within the meaning of the Act upon completion of such processing, labeling, or repacking. Such person and such operator shall each keep a copy of such agreement until all such shipment or delivery has been removed from such establishment, and shall make such copies available for inspection at any reasonable hour to any officer or employee of the Agency who requests them.

*c*) An exemption of a shipment or other delivery of a food under paragraph (*b*) (1) of this section shall, at the beginning of the act of removing such ship-

ment or delivery, or any part thereof, from such establishment, become void *ab initio* if the food comprising such shipment, delivery, or part is adulterated or misbranded within the meaning of the Act when so removed.

(*d*) An exemption of a shipment or other delivery of a food under paragraph (*b*) (2) of this section shall become void *ab initio* with respect to the person who introduced such shipment or delivery into interstate commerce upon refusal by such person to make available for inspection a copy of the agreement, as required by such paragraph.

(*e*) An exemption of a shipment or other delivery of a food under paragraph (*b*) (2) of this section shall expire:

(1) At the beginning of the act of removing such shipment or delivery, or any part thereof, from such establishment if the food comprising such shipment, delivery, or part is adulterated or misbranded within the meaning of the Act when so removed; or

(2) Upon refusal by the operator of the establishment where such food is to be processed, labeled, or repacked, to make available for inspection a copy of the agreement, as required by such paragraph.

### TOLERANCES FOR POISONOUS INGREDIENTS IN FOOD AND CERTIFICATION OF COAL-TAR COLORS FOR FOOD

SEC. 406. (*a*) Any poisonous or deleterious substance added to any food, except where such substance is required in the production thereof or cannot be avoided by good manufacturing practice shall be deemed to be unsafe for purposes of the application of clause (2) of section 402 (*a*); but when such substance is so required or cannot be so avoided, the Administrator shall promulgate regulations limiting the quantity therein or thereon to such extent as he finds necessary for the protection of public health, and any quantity exceeding the limits so fixed shall also be deemed to be unsafe for purposes of the application of clause (2) of section 402 (*a*). While such a regulation is in effect limiting the quantity of any such substance in the case of any food, such food shall not, by reason of bearing or containing any added amount of such substance, be considered to be adulterated within the meaning of clause (1) of section 402 (*a*). In determining the quantity of such added substance to be tolerated in or on different articles of food the Administrator shall take into account the extent to which the use of such substance is required or cannot be avoided in the production of each such article, and the other ways in which the consumer may be affected by the same or other poisonous or deleterious substances.

(*b*) The Administrator shall promulgate regulations providing for the listing of coal-tar colors which are harmless and suitable for use in food and for the certification of batches of such colors, with or without harmless diluents.

## CHAPTER V—DRUGS AND DEVICES

## CHAPTER VI—COSMETICS

## CHAPTER VII—GENERAL ADMINISTRATIVE PROVISIONS

## CHAPTER VIII—IMPORTS AND EXPORTS

## CHAPTER IX—MISCELLANEOUS

SEC. 902. (*b*) Meats and meat food products shall be exempt from the provisions of this Act to the extent of the application or the extension thereto of the Meat Inspection Act, approved March 4, 1907, as amended (U. S. C., 1934 ed., title 21, secs. 71-91; 34 Stat. 1260 *et seq.*).

### Regulations Governing the

# MEAT INSPECTION

### of the United States Department of Agriculture

### EDITION OF JUNE 1952

.18.10 Prescribed treatment of pork and products containing pork to destroy trichinae. (a) All forms of fresh pork, including fresh unsmoked sausage containing pork muscle tissue, and pork such as hams, shoulders, shoulder picnics, bacon, and jowls, which are subjected only to curing or to smoking at temperatures that do not impart to the meat the appearance of being cooked, are classed as products that are customarily well cooked in the home or elsewhere before being served to the consumer. Therefore, the treatment of such products for the destruction of trichinæ is not required.

(b) Products containing pork muscle tissue (including hearts, pork stomachs and pork livers) or the pork muscle tissue which forms an ingredient of such products, including, or of the character of, those named in this paragraph, are classed as articles which shall be effectively heated, refrigerated, or cured at a federally inspected establishment to destroy any possible live trichinæ: Bologna; frankfurts; viennas; smoked sausage; knoblauch sausage; mortadella; all forms of summer or dried sausage, including mettwurst; cooked loaves; roasted, baked, boiled, or cooked ham, pork shoulder, or pork shoulder picnic; Italian-style ham; Westphalia-style ham; smoked boneless pork shoulder butts; cured meat rolls; capocollo (capicola, capacola); coppa; fresh or cured boneless pork shoulder butts, hams, loins, shoulders picnics, and similar pork cuts, in casings or other containers in which ready-to-eat delicatessen articles are customarily enclosed; cured boneless pork loin; boneless back bacon (Canadian style bacon); pork cuts such as hams, shoulders and picnics, which are subjected to smoking at sufficiently high temperatures to impart a partially cooked appearance to the meat (ordinarily, such cuts fall in this class when heated to an internal temperature above 120° F.).

(c) The treatment shall consist of heating, refrigerating, or curing, as follows:

(1) *Heating.* All parts of the pork muscle tissue shall be heated to a temperature not lower than 137° F., and the method used shall be one known to insure such a result. On account of differences in methods of heating and in weights of products undergoing treatment it is impracticable to specify details of procedures for all cases. Procedures which insure the proper heating of all parts of the product shall be adopted. It is important that each piece of sausage, each ham, and other product treated by heating in water be kept entirely submerged throughout the heating period, and that the largest pieces in a lot, the innermost links of bunched sausage or other massed articles, and pieces placed in the coolest part of a heating cabinet or compartment or vat be included in the temperature tests.

(2) *Refrigerating.* At any stage of preparation and after preparatory chilling to a temperature of not above 40° F. or preparatory freezing, all parts of the muscle tissue of pork or product containing such tissue shall be subjected continuously to a temperature not higher than one of those specified in table 1, the duration of such refrigeration at the specified temperature being dependent on the thickness of the meat or inside dimensions of the container.

TABLE 1 *Required period of freezing at temperature indicated*

| *Temperature* | *Group 1* | *Group 2* |
|---|---|---|
| *°F* | *Days* | *Days* |
| 5 | 20 | 30 |
| 10 | 10 | 20 |
| 20 | 6 | 12 |

Group 1 comprises product in separate pieces not exceeding 6 inches in thickness, or arranged on separate racks with the layers not exceeding 6 inches in depth, or stored in crates or boxes not exceeding 6 inches in depth, or stored as solidly frozen blocks not exceeding 6 inches in thickness.

Group 2 comprises product in pieces, layers, or within containers, the thickness of which exceeds 6 inches but not 27 inches, and product in containers including tierces, barrels, kegs, and cartons having a thickness not exceeding 27 inches.

The product undergoing such refrigeration or the containers thereof shall be so spaced while in the freezer as will insure a free circulation of air between the pieces of meat, layers, blocks, boxes, barrels, and tierces in order that the temperature of the meat throughout will be promptly reduced to not higher than 5° F., —10° F., or —20° F., as the case may be.

During the period of refrigeration the product or lot thereof shall be kept separate from other products and in the custody of the division. Rooms or compartments equipped for being made secure with division lock or seal shall be provided. The rooms or compartments containing product undergoing freezing shall be equipped with accurate thermometers placed at or above the highest level at which the product undergoing treatment is stored and away from refrigerating coils. After the prescribed freezing has been finished, the product shall be kept under close supervision of an inspector until it is prepared in finished form as one of the articles enumerated in paragraph (b) of this section or until it is transferred under division control to another establishment for preparation in finished form.

Pork which has been refrigerated as herein specified may be transferred in sealed railroad cars, sealed motortrucks, sealed wagons, or sealed closed containers to another official establishment at the same or another station for use in the preparation of meat and product of a kind customarily eaten without cooking by the consumer. The sealing of closed containers, such as boxes and slack barrels, shall be effected by cording and affixing thereto division seals, and such containers as tierces and kegs shall be held in division custody by sealing with wax impressed with a division metal brand. Railroad cars, motortrucks, and wagons shall, when necessary, be sealed with division car seals. Properly sealed and marked closed containers may be shipped with other meat in unsealed railroad cars, motortrucks, and wagons. Containers such as boxes, barrels, and tierces shall be plainly and conspicuously marked with a label or stencil furnished by the establishment, as follows: "Pork product ——— degrees F. ——— days' refrigeration," indicating the temperature at which the product was refrigerated and length of time so treated. For each consignment there shall be promptly issued and forwarded to the inspector in charge at destination a report on the form entitled "Notice of Unmarked Meats Shipped that the contents are "Pork product ——— degrees F. ——— days' refrigeration." A duplicate copy shall be retained in the station file. Cured boneless pork loins shall be subjected to prescribed treatment for destruction of trichinæ prior to being shipped from the establishment where cured. Such cured boneless pork loins may then be shipped to other official establishments without sealing but they shall carry the mark of inspection.

(3) *Curing*—(i) *Sausage.* Sausage may be stuffed in animal casings, hydrocellulose casings, or cloth bags. During any stage of treating the sausage for the destruction of live trichinæ, except as provided in method 5, these coverings shall not be coated with paraffin or like substance, nor shall any sausage be washed during any prescribed period of drying. In the preparation of sausage, one of the following methods may be used:

*Method No. 1.* The meat shall be ground or chopped into pieces not exceeding three-fourths of an inch in diameter. A dry-curing mixture containing not less than 3⅓ pounds of salt to each hundredweight of the unstuffed sausage shall be thoroughly mixed with the ground or chopped meat. After being stuffed, sausage having a diameter not exceeding 3½ inches, measured at the time of stuffing, shall be held in a drying room not less than 20 days at a temperature not lower than 45° F., except that in sausage of the variety known as pepperoni, if in casings not exceeding 1⅜ inches in diameter measured at the time of stuffing, the period of drying may be reduced to 15 days. In no case, however, shall the sausage be released from the drying room in less than 25 days from the time the curing materials are added.

except that sausage of the variety known as pepperoni, if in casings not exceeding the size specified, may be released at the expiration of 20 days from the time the curing materials are added. Sausage in casings exceeding 3½ inches, but not exceeding 4 inches, in diameter at the time of stuffing, shall be held in a drying room not less than 35 days at a temperature not lower than 45° F., and in no case shall the sausage be released from the drying room in less than 40 days from the time the curing materials are added to the meat.

*Method No. 2.* The meat shall be ground or chopped into pieces not exceeding three-fourths of an inch in diameter. A dry-curing mixture containing not less than 3⅓ pounds of salt to each hundredweight of the unstuffed sausage shall be thoroughly mixed with the ground or chopped meat. After being stuffed, the sausage having a diameter not exceeding 3½ inches, measured at the time of stuffing, shall be smoked not less than 40 hours at a temperature not lower than 80° F., and finally held in a drying room not less than 10 days at a temperature not lower than 45° F. In no case, however, shall the sausage be released from the drying room in less than 18 days from the time the curing materials are added to the meat. Sausage exceeding 3½ inches, but not exceeding 4 inches, in diameter at the time of stuffing, shall be held in a drying room, following smoking as above indicated, not less than 25 days at a temperature not lower than 45° F., and in no case shall the sausage be released from the drying room in less than 33 days from the time the curing materials are added to the meat.

*Method No. 3.* The meat shall be ground or chopped into pieces not exceeding three-fourths of an inch in diameter. A dry-curing mixture containing not less than 3⅓ pounds of salt to each hundredweight of the unstuffed sausage shall be thoroughly mixed with the ground or chopped meat. After admixture with the salt and other curing materials and before stuffing, the ground or chopped meat shall be held at a temperature not lower than 34° F. for not less than 36 hours. After being stuffed the sausage shall be held at a temperature not lower than 34° F. for an additional period of time sufficient to make a total of not less than 144 hours from the time the curing materials are added to the meat, or the sausage shall be held for the time specified in a pickle-curing medium of not less than 50° strength (salometer reading) at a temperature not lower than 44° F. Finally, the sausage having a diameter not exceeding 3½ inches, measured at the time of stuffing, shall be smoked for not less than 12 hours. The temperature of the smokehouse during this period at no time shall be lower than 90° F.; and for 4 consecutive hours of this period the smokehouse shall be maintained at a temperature not lower than 128° F. Sausage exceeding 3½ inches, but not exceeding 4 inches, in diameter at the time of stuffing shall be smoked, following the prescribed curing, for not less than 15 hours. The temperature of the smokehouse during the 15-hour period shall at no time be lower than 90° F., and for 7 consecutive hours of this period the smokehouse shall be maintained at a temperature not lower than 128° F. In regulating the temperature of the smokehouse for the treatment of sausage under this method, the temperature of 128° F. shall be attained gradually during a period of not less [illegible]

heating and smoking, however, shall be in addition to the 35-day holding period specified.

*Method No. 5.* The meat shall be ground or chopped into pieces not exceeding three-fourths of an inch in diameter. A dry-curing mixture containing not less than $3\frac{1}{3}$ pounds of salt to each hundredweight of the unstuffed sausage shall be thoroughly mixed with the ground or chopped meat. After being stuffed the sausage shall be held for not less than 65 days at a temperature not lower than 45° F. The coverings for sausage prepared according to this method may be coated at any stage of the preparation before or during the holding period with paraffin or other substance approved by the chief of division.

(ii) *Capocollo* (*capicola, capacola*). Boneless pork butts for capocollo shall be cured in a dry-curing mixture containing not less than $4\frac{1}{2}$ pounds of salt per hundredweight of meat for a period of not less than 25 days at a temperature not lower than 36° F. If the curing materials are applied to the butts by the process known as churning, a small quantity of pickle may be added. During the curing period the butts may be overhauled according to any of the usual processes of overhauling, including the addition of pickle or dry salt if desired. The butts shall not be subjected during or after curing to any treatment designed to remove salt from the meat, except that superficial washing may be allowed. After being stuffed, the product shall be smoked for a period of not less than 30 hours at a temperature not lower than 80° F., and shall finally be held in a drying room not less than 20 days at a temperature not lower than 45° F.

(iii) *Coppa.* Boneless pork butts for coppa shall be cured in a dry-curing mixture containing not less than $4\frac{1}{2}$ pounds of salt per hundredweight of meat for a period of not less than 18 days at a temperature not lower than 36° F. If the curing mixture is applied to the butts by the process known as churning, a small quantity of pickle may be added. During the curing period the butts may be overhauled according to any of the usual processes of overhauling, including the addition of pickle or dry salt if desired. The butts shall not be subjected during or after curing to any treatment designed to remove salt from the meat, except that superficial washing may be allowed. After being stuffed, the product shall be held in a drying room not less than 35 days at a temperature not lower than 45° F.

(iv) *Hams.* In the curing of hams either of the following methods may be used:

*Method No. 1.* The hams shall be cured by a dry-salt curing process not less than 40 days at a temperature not lower than 36° F. The hams shall be laid down in salt, not less than 4 pounds to each hundredweight of hams, the salt being applied in a thorough manner to the lean meat of each ham. When placed in cure the hams may be pumped with pickle if desired. At least once during the curing process the hams shall be overhauled and additional salt applied, if necessary, so that the lean meat of each ham is thoroughly covered. After removal from cure the hams may be soaked in water at a temperature not higher than 70° F. for not more than 15 hours, during which time the water may be changed once; but they shall not be subjected to any other treatment designed to remove salt from the meat, except that superficial washing may be allowed. The hams shall finally be dried or smoked [illegible]

dried or smoked not less than 48 hours at a temperature not lower than 80° F., and finally shall be held in a drying room not less than 20 days at a temperature not lower than 45° F.

(v) *Boneless pork loins and loin ends.* In lieu of heating or refrigerating to destroy trichinæ in boneless loins, the loins shall be cured for a period of not less than 25 days at a temperature not lower than 36° F. by the use of one of the following methods:

*Method No. 1.* A dry-salt curing mixture containing not less than 5 pounds of salt to each hundredweight of meat.

*Method No. 2.* A pickle solution of not less than 80° strength (salometer) on the basis of not less than 60 pounds of pickle to each hundredweight of meat.

*Method No. 3.* A pickle solution added to the approved dry-salt cure provided the pickle solution is not less than 80° strength (salometer).

After removal from cure, the loins may be soaked in water for not more than 1 hour at a temperature not higher than 70° F. or washed under a spray but shall not be subjected, during or after the curing process, to any other treatment designed to remove salt.

Following curing, the loins shall be smoked for not less than 12 hours. The minimum temperature of the smokehouse during this period at no time shall be lower than 100° F., and for 4 consecutive hours of this period the smokehouse shall be maintained at a temperature not lower than 125° F.

Finally, the product shall be held in a drying room for a period of not less than 12 days at a temperature not lower than 45° F.

(d) *General instruction.* When necessary to comply with these instructions, the smokehouses, drying rooms, and other compartments used in the treatment of pork to destroy trichinæ shall be suitably equipped, by the establishment, with accurate automatic recording thermometers. Inspectors in charge are authorized to approve for use in sausage smokehouses, drying rooms, and other compartments, such automatic recording thermometers as are found to give satisfactory service.

To insure the effective administration of the foregoing, inspectors who supervise the handling and treatment of pork to destroy live trichinæ shall:

(*1*) Recognize the importance of safeguarding the consumer and follow carefully the instructions concerning the treatment of pork to destroy trichinæ.

(*2*) Check the internal temperatures, with division thermometers, of all products subjected to the heating method.

(*3*) Test frequently, with division thermometers, the reliability of establishment thermometers (including automatic recording thermometers) and reject for use any found to be inaccurate and unreliable.

(*4*) Observe division thermometers carefully in order that none be used which have become defective or of questionable accuracy.

(*5*) Supervise in a methodical manner the handling, in drying, refrigerating, and curing departments, of pork product under treatment for the destruction of live trichinæ, and keep conveniently available, at the official establishment for division use, such records as may be necessary and informative of each lot of product under treatment

## GLOSSARY

(Compiled by Dr. Ralph D. Barner, Professor of Veterinary Medicine, Michigan State University)

**Aged beef.**—Meat stored 2-8 weeks at 36°-38° F., more tender than fresh meat due to enzyme action.
**Aitch bone.**—Os coxarum.
**Ante-mortem.**—Before death or slaughter.
**Baby beef.**—Force fed steers under 15 months of age and weighing 900 pounds or less.
**Back (lamb).**—A wholesale cut includes all chops of lamb carcass.
**Back packing.**—Storing at low temperatures, not for immediate sale.
**Bald spot.**—Exposed muscle at point of pubic symphysis in male carcasses (cattle).
**Bangers.**—Cows failing to pass the Bang's disease test.
**Barrow.**—Castrated male swine.
**Beef.**—Meat derived from cattle one year old or more.
**Beef bladder.**—Urinary bladder used for sausage casing.
**Beef bung.**—Cecum and part of folded colon.
**Beef middles.**—All but first 4 feet of colon used in bungs.
**Beef trimmings.**—Boneless lean meat unsuitable for retail trade, used in sausages.
**Beef rounds.**—Small intestine up to ileo-cecal valve.
**Blood sausage.**—Blood, pork, beef, fat, spices, cooked and in large casings.
**Boar.**—Mature male swine.
**Bobs.**—High, thin veals
**Bob veal.**—Immature veal less than 10 days old.
**Boneless beef.**—Trimmed wholesale cuts.
**Boners.**—Cheap, low grade cattle, the product of which is boned before the meat is sold.
**Bolognas.**—Dairy type bulls used in making sausage filling.
**Booster.**—Any salesman.
**Boston butts.**—Upper part of pork shoulder including suprascapular cartilage. Sometimes cured.
**Boston weights.**—Heavy plain steers, usually rough in finish, yielding a lean beef.
**Boulevard.**—A main stockyard alley.
**Bow-Wow.**—A small stunted aged steer with no quality, unsuited either for beef or feeder purposes. Utilized sometimes as canners or cutters.
**Boy Clubs.**—Steers and heifers individually sold, fed by 4-H Club and Future Farmer juveniles.
**Bums.**—Light western lambs disowned by dams and forced to "bum" milk from other ewes.
**Butcher cattle.**—Well finished cattle that yield high quality meats.
**Brawn.**—Similar to head cheese, made from trimmings.
**Break joint.**—Distal epiphyseal cartilage of metacarpus of lamb.
**Bust.**—A hog that is ruptured. These are docked 10 to 30 pounds or sold at a lower price per pound.
**Buttons.**—(Beef carcasses) cartilagenous ends of the spinous processes of the thoracic

**Cap leaks.**—Leaks around the solder of a can cap.

**Carcass.**—Dressed body of cattle, sheep, swine or goat.

**Car routes.**—A type of light, lower cost, fleshy steers yielding beef that goes to smaller urban centers.

**Casings.**—Sheep casings—up to ileo cecal valve, hog casings—same, artificial casings—cellulose.

**Cattalo.**—Cattle showing a buffalo-domestic cow cross.

**Caul fat.**—Omental and mesentery fat.

**Cheaters.**—Feeders with a reputation, who lose it by marketing less desirable cattle. Sometimes a feeder will ship these cattle under assumed names to avoid impairing reputation.

**Chicken eaters.**—Thin sows, keeps that way by activity in the barnyard.

**Chine bone.**—Superior spines of vertebræ, especially thoracic.

**Chitterling.**—Large intestine of swine.

**Choppers.**—Aged ewes in medium flesh, not good enough to grade as fat.

**Closed side (beef).**—Right side of beef, with kidney attached.

**Cold blood.**—Low grade steers.

**Cold slaughter.**—Carcass from animal dead of some cause not slaughter.

**Collapsed can.**—Improperly filled cans that buckle under vacuum.

**Collies.**—Western lambs fed in Colorado.

**Comebacks.**—Western lambs run in cornfields for a brief period to make cheap gains.

**Condemned.**—Products unfit for food as judged by inspectors.

**Conformation.**—General build, form, shape or outline of a carcass or cut.

**Cooking oil.**—Deodorized and neutralized vegetable oil used for cooking or edible purposes.

**Counterfeit.**—Descriptive of cattle of good color giving the impression of good breeding that they do not possess. For example, cattle showing Hereford markings but lacking Hereford conformation and quality.

**Crips or Downers.**—An animal that has been hurt or crippled.

**Crip cart.**—Vehicle in which downers or crips are hauled to the packing house.

**Crows.**—Lambs that do not respond to feed.

**Culls and Throwouts.**—The cheaper, less desirable classes of animals.

**Cured meat.**—Salted or brined with or without sugar, spice, nitrates, etc.

**Cutter.**—Animals slightly better than canners but not good enough for dressed beef.

**Dairies.**—Any kind of a dairy cow culled from milk herds.

**Deacon.**—A young calf not mature enough for veal.

**Deckel (corned beef).**—Sternum, costal cartilages and sternal muscles after trimmed from the side.

**Dingers.**—Inferior light lambs.

**Dockage.**—A specified weight deduction, i.e., 40 pounds on pregnant cows, 70

**Free martin.**—Heifer born twin with a bull, imperfectly sexed and barren as a rule.
**Freshly chilled.**—36°–40° F. for storage of recently killed carcasses.
**Fresh frozen.**—Refrigeration of freshly chilled carcasses at 10° F. for up to six months.
**Fresh meat.**—No change in character since slaughter.
**Forefeet (swine).**—Front feet (more desirable than rear), may be fresh cooked, pickled or jellied.
**Fore saddle.**—Unsplit carcass of lamb or veal from the 12th rib forward.
**Gamblers.**—Steers of uncertain quality or dressed yield, with a doubtful outcome in the beef.
**Gambrel.**—Stick for suspending carcasses from the rail.
**Government.**—Animals thrown out by government inspectors. They may or may not be condemned as unfit for food.
**Grass widows.**—Sows that have recently weened litters.
**Half sheets.**—Spare rib ends with costal cartilages attached.
**Handy weights.**—Beef cattle at 850–1000 pounds.
**Hanging tenderloin.**—Pillar of diaphragm on the left or "open" side of the carcass, usually 3–4 pounds and in beef carcasses only.
**Hard feeders.**—Dairy type steers that cannot be fattened economically.
**Heart cap.**—Blood vessels, auricles and connective tissue at top of untrimmed heart.
**Heiferettes.**—Heifers that have lost their girlish figures, having had one calf.
**Highlanders.**—The progeny of shaggy parents originally imported from the Scottish Highlands. Rare.
**Hind saddle.**—Unsplit rear half of veal or lamb carcass from 12th rib back.
**Hocks (pork).**—Carpus to olecrannon or tarsus to patella as sometimes trimmed in making short cut hams and shoulders.
**Holdovers.**—Stock not sold on the day of arrival at the yard.
**Horses.**—Long-legged common cattle and sheep.
**Hot house lamb.**—20–35 pound lambs marketed between January and March usually raised under cover.
**Humps.**—Southwestern steers showing a remote or recent Brahma cross.
**In-between-kinds.**—Stock that is border line in any classification, not killers and not feeders.
**Jowls.**—Fatty portion of hog carcass between shoulder and jaw, usually cured and sold under a variety of trade names, butts, squares, dixies, etc.
**Judas.**—A goat trained to lead sheep up to the killing floor.
**Jack-Pot.**—Mixed lot of cattle, usually of common quality.
**Kidney knob.**—Usually beef kidney and surrounding fat.
**Killer.**—A meat packer.
**Killing cattle.**—Cattle in condition for slaughter.
**Kosher.**—Clean, lawful. Meat slaughtered according to Hebrew or Talmud Law.
**Lard.**—Rendered fresh hog fat.
**Lard substituto.**—Vegetable or animal and vegetable fats, edible.
**Leaf lard.**—Internal fat exclusive of caul and mesentery fat.
**Lights.**—Lungs.
**Links.**—Dividing interval of sausage in casings.
**Loin shell.**—A short loin of beef with tenderloin removed.
**Long-cut ham.**—Long shank ham and sometimes cut leaving os coxae all on the ham (cut at "slip joint").
**Long-cut tongue.**—The tongue as removed from the head, includes fractured hyoids, salivary glands, pharyngeal wall and frequently part of larynx.
**Long-fed cattle.**—Cattle fed 6–9 months or more to make finished beef.
**Lumps.**—Cattle showing lumpy jaws.

**Meat loaf.**—Comminuted meat with spices, cereal, eggs, milk powder pressed into a loaf.
**Meat skipper.**—Larvæ of a small black fly attacking smoked meats.
**Melt.**—(Spleen).
**Mice.**—Undersized lambs, not necessarily thin.
**Mongrels.**—Scrubs. Animals of unknown or poor ancestors.
**Mudders.**—Cattle fed in a muddy feed lot; always penalized in price.
**Mutton.**—Sheep meat.
**Nannies.**—Aged ewes.
**Near packers.**—Not quite enough finish for the better slaughter grades.
**Neck bones.**—In pork the cervical and first 3–4 cervical vertebræ.
**Nellies.**—Canners.
**New York Style Shoulder.**—Long cut shoulder trimmed above the carpus and above the scapula, all flaps and bones trimmed close.
**Nurse cows.**—Milch cows that furnish additional supply of milk for feeding calves (not their own) to give better flesh and finish.
**Nutcrackers.**—Hogs fattened on acorns and other mast.
**Offal.**—Products other than carcass, includes edible parts—tongue, liver and glands used pharmaceutically.
**Oleo stock.**—Clarified oil from beef fat.
**Open side.**—Left side of beef carcass, loose kidney and hanging tenderloin.
**Overflow.**—Internal fat covering internal thoracic wall in beef.
**Overhauling.**—Examination and restacking meat in curing process.
**Overstuffed cans.**—Over filled, bulging cans.
**Packer.**—An animal that has been used as a brood sow, usually weighty and rough. Generally sells at a a range of from $1.00 to $2.50 per hundredweight lower than good hogs.
**Packer cans.**—Cans with soldered seams and a hole in the cap for filling.
**Peanuts.**—Soft hogs fed on peanuts.
**Pea Vines.**—Low grade steers fattened on cannery refuse.
**Pewees.**—Small stunted pigs or lambs.
**Picnic.**—Lower end of pork shoulder, trimmed across top of scapula and above carpus.
**Pig.**—Young swine, sexually immature
**Pizzle eye.**—(Beef) remnants of crural attachments of penis.
**Pluck.**—Thoracic viscera, includes liver in swine.
**Pork.** Meat derived from swine
**Pork trimmings.** Lean pork scraps, used in sausage production.
**Post-mortem.** After death, referring to inspection, examination of viscera and carcass

**Salami style sausage.**—A summer sausage of highly seasoned, coarsely chopped pork and beef.

**Salometer.**—A type of hydrometer for testing specific gravity of brine or pickle fluid.

**Sandhill cattle.**—Cattle raised in western Nebraska.

**Sappy.**—Applied to lambs freshly taken from the ewes and carrying milk fat.

**Sausage meat.**—Ground meat, fresh or prepared or both.

**Scabs.**—Any livestock affected with parasites. Usually sheep.

**Scenery feds.**—Cattle or lambs permitted to go hungry in the feed lot. Always penalized in price.

**Scrapple.**—A cooked meat, cereal and seasoning mixture.

**Scribe cut bellies.**—Bellies damaged by the scribe saw at the time the ribs are cut from the loin.

**Second pickle.**—Pickling medium used a second time.

**Seconds.**—Animals bought by traders and scalpers for resale through commission agents.

**Seedy bellies.**—Sow bellies with grey or black mammary gland tissue visible.

**She stuff.**—Cows and heifers.

**Shippers.**—Livestock acquired by order buyers to ship elsewhere for processing.

**Shoat.**—Young hogs usually 60–100 pounds (sometimes up to 140 pounds).

**Short cut ham.**—Regular cut ham.

**Short cut tongue.**—Trimmed tongue, no glands, cartilage or bones.

**Short fed.**—Cattle fed 60–120 days but not quite choice butcher stock.

**Short vacuum cans.**—Incompletely exhausted can.

**Shrinkage.**—Of meat, decrease in weight during storage of livestock, decrease in live weight in transit.

**Shroud.**—A porous cloth used to wrap meat while chilling.

**Siding.**—Usually indicates skinning out the sides of a beef carcass.

**Sinker.**—A properly slaughtered hog that sinks to the bottom of the scalding vat and is partially cooked.

**Sirloin strip.**—A short loin from which the bones and tenderloin have been removed.

**Skewer.**—A wooden or metal pin used to fasten meat strips and shrouds.

**Skin.**—A very thin and common hog.

**Skinned ham.**—Skin removed except around shank.

**Skip.**—A generic term for expressing inferiority. Usually light hogs.

**Skirt.**—The diaphragm attached to a side of beef.

**Slaughter cattle.**—Mature cattle of sufficient size and finish to kill profitably.

**Slip joint.**—Sacro-iliac articulation.

**Slow leaker cans.**—Tiny leaks usually located by squeezing the can.

**Smithfield hams.**—Peanut fed, cold smoked, long cut hams that are well peppered and prepared at Smithfield, Virginia.

**Smithfield style hams.**—Hams cured by this process at any other place.

**Smoked meats.**—Fresh, dried or cured meat subjected to smoke from hard wood fires.

**Souse.**—A cooked meat product packed in vinegar.

**Sow.**—Female hog having one or more litters of pigs.

**Spare-ribs.**—Pork ribs after belly and loin are removed.

**Spencer roll.**—A boneless beef cut from upper ends of ribs and longissimus dorsi muscle.

**Spotter.**—A beef carcass with hemorrhagic spots due to incomplete bleeding.

**Spring lambs.**—Good quality grain fed lambs that are under 8 months old, usually quite light in weight.

**Springer cows.**—Cows due to freshen soon.

**Springers.**—Cans—bulging end due to overfilling one end; affected cows—animal during last 2 months gestation.

**Stag.**—Male animals castrated after sexual maturity.

**Stalers.**—Animals not sold on the day of arrival at a market (held over).

**Stearin.**—White solid material, composed of glycerine and stearic acid.

**Steer.**—Castrate male bovine, castrated before maturity.

**Sterilamps.**—Ultraviolet lamps used to destroy surface bacteria.

**Stickers.**—Animals difficult to sell.
**Stillers.**—Cattle fed on distillery mash.
**Stock bull.**—One used for breeding purposes.
**Stock calf.**—One that will feed out a good beef carcass.
**Stock cattle.**—Young steers and cows that are light in weight and usually immature.
**Stocker cattle.**—Cattle that must be fed out to kill profitably.
**Straight across.**—Animals of a shipment all sold without sorting, none thrown out.
**Straw stackers.**—Dried out cattle and sheep, fed on straw or common roughage.
**Strubite.**—Ammonium magnesium phosphate crystals that form in many canned sea foods, cause mouth injury and render the product unfit for food.
**Suet.**—Animal fat, usually of beef but also used to include mutton.
**Sugars.**—Cattle fed on pulp at refineries in the beet growing sections of Colorado, Nebraska and Wyoming.
**Summer sausage.**—A dried uncooked sausage.
**Sunfish.**—Narrow, thin chested, common cattle.
**Swamp angels.**—Inferior cattle grown in southern cane brakes.
**Sweet breads.**—Thymus gland of calves, cervical and thoracic portions.
**Sweet pickle.**—A brine or pickling solution containing sugar.
**Swells.**—Can bulging on both ends.
**Tail-end.**—That which is left after the more desirable individuals are sorted out of a drove; the poorer individuals in a car or drove.
**Tallow.**—Rendered fat of beef or mutton origin.
**Tenderloin.**—(Filet mignon) a boneless cut of meat, the psoas muscles.
**Thin.**—An animal very poor in flesh, regardless of weight.
**Throw-outs.**—Animals sorted out to make a certain lot more uniform.
**Tops.**—The best of a lot, shipment or days receipts at a market.
**Touched.**—Animals shipped because of exposure to an infectious disease.
**Traders or Specs.**—Market operators who buy and sell on their open account. Also termed "the boys". Their trade is extremely hazardous.
**Trees.**—Metal racks used for hanging hams, bacon, sausage, etc., while smoking.
**Triangle.**—Portion of lamb carcass after long cut saddle is removed. Flank, plate, shoulder, shank and neck
**Trichina.**—Trichinella spiralis nematodes of swine transmissible to man. Causing trichinosis.
**Tripe.**—Cleaned denuded rumen and reticulum.
**Turps.**—Southern inferior cattle, so-called because they are credited with fattening on turpentine.
**Two-way cattle.**—Fleshy steers weighing 900–1,000 pounds, adapted to the feed lot or the beef rail.
**Veal.**—Meat from young bovine animals usually 1–3 months old.
**Vent leaks.**—Leaks of the soldered vent in cans.
**Viscera.**—All organs of thoracic and abdominal cavities.
**Warmed-up.**—Thin cattle that have been on corn feed just long enough to show effects, but not long enough to be desirable beef.
**Washy.**—Descriptive of feed such as new grass or other freshly grown vegetation that has a clearing effect upon the digestive tract but does not make good hard flesh, applied to animals fed on such feed.
**Weasand.**—Esophageal mucosa used for sausage casing.
**Wet cows.**—Milking cows.
**Wether.**—Male sheep castrated before maturity.
**Whitefaces.**—Hereford cattle or fine wooled sheep. Black face sheep are usually crosses using mutton type rams.
**Wiltshire side.**—An export cut of pork, includes the ham, side and shoulder all in one piece
**Wooden.**—Cattle, sheep or lambs improperly fed, insuring inferior yields and low grade meat
**Yearlings.**—Animals beyond the calf or lamb age but under two years of age.
**Yellowhammer.**—Dogey. Southern bred, inferior steers, cows and heifers. The name indicates a tawny hue.
**Yorker.**—Hogs weighing 160–190 pounds of a smooth, choice type.

# BIBLIOGRAPHY


AKIBA, MINORU: Studies of Bound Water in Fish Meat Muscle, Bulletin of the Faculty of Fisheries, Hokkaido University, *2*, No. 3, 176–213, 1951.

ALBERTSON, *et al.*: Meat Hygiene, WHO-FAO, Geneva 1957.

AMERICAN CAN COMPANY RESEARCH DIVISION: The Canned Food Reference Manual, New York, American Can Company, 1947.

AMERICAN MEAT INSTITUTE: Beef, Veal, and Lamb Operations, 4th ed., Chicago, Illinois Institute of Meat Packing, University of Chicago, 1945.

AMERICAN MEAT INSTITUTE: Pork Operations, 5th ed., Chicago, Illinois, Institute of Meat Packing, University of Chicago, 1944.

AMERICAN PUBLIC HEALTH ASSOCIATION and AMERICAN WATER WORKS ASSOCIATION: Standard Methods for the Examination of Water and Sewage, 9th ed., New York, American Public Health Association, 1946.

AMERICAN WATER WORKS ASSOCIATION: Water Works Practices Manual, Baltimore, The Williams and Wilkins Company, 1925.

ANDREWS, MONA M., GUTHNECK, BARBARA T., MCBRIDE, B. H., and SCHWEIGERT, B. A.: Stability of Certain Respiratory and Glycolytic Enzyme Systems in Animal Tissue, Journal of Biological Chemistry, *194*, 715–719, 1952.

AYERS, J. C., OGILVY, U. S., and STEWART, G. F.: Postmortem Changes in Meats. I Microorganisms Associated with Development of Slime on Eviscerated Cut-up Poultry, Food Technol., *4*, 199, 1950.

BAILEY, A. E.: Industrial Oil and Fat Products, New York, Interscience Publishers, Inc., 1945.

BARNES, T. C., and JAHN T. L.: Properties of Water of Biological Interest, Quarterly Review of Biology, *9*, 292–341, 1934.

BATE-SMITH, E. C.: Physiology and Chemistry of Rigor Mortis, Advances in Food Research, *1*, 1948.

BATZER, O. F. and DOTY, D. M.: Radiation Sterilization, Ag. and Food Chem., *51*, 64–67, 1955.

BEAUDETTE, F. R.: Psittacosis, Rutgers University Press, New Brunswick, N. J., 1955.

BELLAMY, W. D., GOLDBLITH, S. A., COLOVAS, G. C., NEVIN, C. F.: Symposium on Applications of Ionizing Radiation of Food and Pharmaceuticals Preservation, Bacteriological Review, *19*, 4, 266–269, 1956.

BIESTER, H. E., and SCHWARTE, L. H.: Diseases of Poultry, 3rd ed., The Iowa State College Press, Ames, 1952.

BLUMENTHAL, SAUL: Food Products, Brooklyn, New York, Chemical Publishing Company, Inc., 1947.

CALLOW, E. H.: Frozen Meat, Jr. of Science of Food and Agriculture, *3*, No. 4, 145–150, 1952.

CASTELLANI, A. G., and NIVEN, C. F.: Factors Affecting the Bacteriostatic Action of Sodium Nitrite, Applied Microbiology, *3*, No. 3, 154–159, 1955.

CLAYTON, S.: Symposium on Human and Animal Sources of Gastro-intestinal infection (*b*) Animal Sources of Food Infection, Royal Sanitary Institute Journal, *74*, 9, 856–872, 1951.

COLEMAN, H. M.: The Mechanism of Meat Pigment Oxidation. The Effect of Solutes on the Hemoglobin-Oxygen Equilibrum. Food Research., *16*, No. 3, 222–229, 1951.

CONLEY, B. E.: Chemical Food Poisoning Prevented, Assoc. F. & D. Officials of the U. S., Quarterly Bulletin, XX, *3*, 121–127, 1956.

COUNCIL ON PHARMACY AND CHEMISTRY: Health Hazards of Electric Vaporizing Devices for Insecticides, Jr. of American Medical Association, 367–369, May 24, 1952.

COWDRY, E. V.: A Textbook of Histology, 4th ed., Philadelphia, Lea & Febiger, 1950.

DACK, G. M.: Food Poisoning, 3rd ed., The University of Chicago Press, Chicago, 1956

DU BOIS, C. W., and TRESSLER, D. K.: Influence of Rates of Freezing and Temperature of Storage on Quality of Frozen Meat, Institute of Food Technology, Proceedings of 1st Conference, 167–179, 1940

DUGAN, L. R.: You Can't Control Rancidity by Ignoring It, American Meat Institute Foundation Circular No 15, March 1955

EDITORIALS and COMMENTS: Infectious Agents in Sewage, The J.A.M.A., *160*, No. 10, 877.

EVANS, J. B., BRADFORD, W. L., NIVENS, C. F.: Comments Concerning the Taxonomy of the Genera Micrococcus and Staphylococcus, International Bul. of Bact. Nomenclature and Taxonomy, *5*, 2, 61–66, 1955.

EVANS, J. B.: The Identity of Staphylococci Associated with Food Poisoning Proceedings of the Second Conference on Research, The Council on Research of the American Meat Institute at the University of Chicago, p. 67-69, March 1950

FERREE, J. W.: Low-Sodium Foods, Correspondence J.A.M.A., 846, March 7, 1953.

FOOD POISONING IN ENGLAND AND WALES, 1954., *Monthly Bulletin of the Ministry of* Health and Public Health Laboratory Service, *14*, 203–216, 1955.

FOREIGN LETTERS (Denmark): Micrococcic Enteritis from Antibiotics, Journal AMA, 412, Feb. 4, 1956.

GALE, E. F.: Enzymes Concerned in the Primary Utilization of Amino Acids, Bact. Rev., *4*, 135–176, 1940.

GEARHART, W. M., and STUCKEY, B. N.: A Comparison of Commercially Used Phenolic Antioxidants in Edible Animal Fats, Jr. of Am. Oil Chem. Society *32*, No. 7, 386–390, 1955.

GETTY, ROBERT: Histopathology of a Focal Hepatitis and of Its Termination, Am. Jr. of Vet. Res., 7, No 25, 1946.

GIBBS, W. M.: Spices and How to Know Them, Buffalo, New York, Matthews-Northrup Works, 1909.

GIBBSON, N. E., and ROSE, D.: Effect of Antemortem Treatment of Pigs on the Quality of Wiltshire Bacon, Canadian Jr. of Res., *28*, 11, 438–450, 1950

GINGER, I. D., LEWIS, V. J., and SWEIGERT, B. S.: Biochemistry of Myoglobin, Ag. & Food Chemistry, *3*, 2, 156–159, 1955.

GOLDBLITH, S. A., and PROCTER, B. E.: Radiation Sterilization, Ag and Food Chem., *3*, 3, 253–256, 1955

GUNTHER, ERNEST: The Essential Oils, Toronto, New York City, London, D. Van Nostrand Co., Inc., 1948.

HAGAN, W. H.: The Infectious Diseases of Domestic Animals, Ithaca, New York, Comstock Publishing Company, Inc, 1947

HAWK, OSER and SUMMERSON: Practical Physiological Chemistry, 12th ed., Philadelphia, The Blakiston Company, 1947

HEALTH PROBLEMS OF VAPORIZING AND FUMIGATING DEVICES FOR INSECTS: Council of *Pharmacy and Chemistry, J.A.M.A., 152, 13, 1232, 1234*, 1953.

HILDITCH, T. P.: The Chemical Composition of Natural Fats, 2nd ed, New York, John Wiley and Sons, Inc., 1947

HILLIG, F.: *Report on Decomposition of Fish Products, Jr* A O.A.C., *522*, 1949.

HINMAN, R. B, and HARRIS, R B: The Story of Meat, Chicago, Swift and Company, 1942.

HINSHAW, W R., and MCNEIL, E Salmonella Infection as a Food Industry Problem, Advances in Food Research, *3*, 209, 1951

HOSHALL, E. M: The Processing of Food with *Ionizing Radiation, Assn. F. & D.* Officials of the U S, Quarterly Bul., XX, *2*, 62–71, 1956

INGRAM, M, BARNES, E M, and SHEWAN, J J: *Problems in the Use of Antibiotics* for Preserving Meat and Fish, Food Science Abstracts, *28*, 2, 121–136, 1956.

INSTITUTE OF AMERICAN MEAT PACKERS: Sausage and Ready-to-Serve Meats, Chicago, Illinois, Institute of Meat Packing, The University of Chicago, 1938

INTERNATIONAL ASSOCIATION OF MICROBIOLOGICAL SOCIETIES: The Bacteriology of Semi-Preserved Meats, Chemistry and Industry, *1503–1504, Dec. 4*, 1954.

JACOBS, M B: The Chemistry and Technology of Food and Food Products, New York Interscience Publishers, Inc, 1944

JAMIESON, G S Vegetable Fats and Oils, 2nd ed, New York, Reinhold Publishing Corp, 1943

JENSEN, L B: Microbiology of Meats, 3rd ed, Champaign, Ill, *The Garrard Press*, 1954

JENSEN, R., *et al*: The Rumenitis-Liver Abscess Complex in Beef Cattle, Am. Jr. of Vet Research, 202, April, 1954

JOHNSON, MIGAKI, and MCCOLLOCK Further Inquiries into the Antibacterial Properties of Cationic and Anionic Detergents, Am *Jr of Pub. Health, 42, No. 7*, 801-805, 1952

JUL, MORGENS *Advances in Meat Canning*, Danish Meat Research Institute Publication No 2, Roskilde, 1957

KAMPSCHMIDT, R F Meat Discoloration—Effect of Wave Length of Light on Discoloration of Cured Meats, Agri and Food Chem, *510-512, June*, 1955

KINSMAN, S: Atomic Bomb Phenomena, Assn of F & D. Officials of the U.S Quarterly Bul XVI, *1*, 9 16, 1952

KRAYBILL, H. R.: Sugar and Other Carbohydrates in Meat Processing, Advances in Chemistry Series, *12*, 83, 88, 1955.

———: Chemicals in the Meat Industry, American Meat Institute Foundation, Cr. No. 14, June, 1955.

KRAYBILL, H. R. and DUGAN, L. R.: Antioxidants New Developments for Food Use, Ag. and Food Chem., *2*, 2, 81–84, 1954.

LAKI, K., SPICER, S. S., and CARROLL, W. R.: Evidence for a Reversible Equilibrum between Actin, Myosin, and Actomyosin, Nature, *169*, 4295, 328–329, 1952.

LEA, C. H.: Rancidity in Edible Fats, New York, Chemical Publishing Company, 1939.

LEHMAN, A. J.: Food Packing Materials, Assn. of F. & D. Officials of the U. S., Quarterly Bul., XX, *4*, 159–167, 1956.

LEHMAN, A. J.: Quaternary Ammonium Sulfactants, Acute and Chronic Toxicity, Quarterly Bul., Assn. F. & D. Officials of the U. S., XVIII, *2*, 43–52, 1951.

LINDSEY and RHINES: The Production of Hydroxylamine by the Reduction of Nitrates and Nitrites by Various Pure Cultures of Bacteria, Journal of Bact., *24*, No. 6, 1932.

MARQUETTE, MONA M., and SCHWEIGERT, B. S.: Stability of the Adenosinetriphosphate System in Animal Tissue, Sci., *111*, 660–661, 1950.

McCARTHY, J. F., and MACKINTOSH, D. L.: Some Observations on the pH of Pork Under Various Conditions, Food Tech., 167–171, April, 1953.

MERCHANT, I. H.: Veterinary Bacteriology, Ames, Iowa, Iowa State College Press, 1948.

MEYER, K. F.: Food Poisoning, The New England Jr. of Med., *249*, 19, 765–852, 1953.

MILLIKAN, G. A.: Muscle Hemoglobin, Physiol. Rev., *191*, 503, 1939.

MINISTER OF AGRICULTURE, FISHERIES AND FOOD: Slaughterhouses, Recommended Minimum Standards for the Construction, Lay-Out and Equipment of Slaughterhouses in England and Wales, Her Majesty's Stationery Office, Cmnd., 243, August 1957.

MITCHELL, P. H.: A Textbook of Biochemistry, New York and London, McGraw-Hill Book Company, 1946

MÖNNIG, H. O.: Veterinary Helminthology and Entomology, London, Baillière, Tindall and Cox, 1947.

MORAN, T., and WRIGHT, N. L.: Store Burn in Frozen Meat and Poultry, Food Manuf., *12*, 344–345.

MORRIS, S. O.: Fat Rancidity, Ag. and Food Chem., *2*, 3, 126–132, 1951.

MOULTON, C. R., and LEWIS, W. L.: Meat Through the Microscope, Chicago, Illinois, Institute of Meat Packing, The University of Chicago, 1940.

NEEDHAM, JOSEPH: The Biochemistry of Muscle, London, Methuen & Company, Ltd., 1932.

NEILL, J. M.: Studies on the Oxidation-reduction of Hemoglobin and Methemoglobin, J. Expt. Med., *41*, 561–570, 1925.

NICHOLS, J. B., and MACKINTOSH, D. L.: Structural Changes Occurring in Muscle Tissue During Repeated Freezing and Thawing, Food Technology, 170–175, May, 1952.

NICKERSON, J. T. R., PROCTOR, B. E., and GOLDBLITH, S. A.: Public Health Aspects of Electronic Food Sterilization, Am. Jr. of Public Health, *43*, 554–560, 1953.

NIVEN, C. F.: Sausage Discolorations of Bacterial Origin, American Meat Institute Foundation, Bulletin No. 13, Dec., 1951.

NIVEN, C. F., and EVANS, J. B.: Popular Misconceptions Concerning Staphylococcus Food Poisoning, Proceedings of the Seventh Research Conference, Sponsored by the Council on Research, American Meat Institute, University of Chicago, March, 1955

OFFICIAL METHODS OF ASSOCIATION OF OFFICIAL AGRICULTURAL CHEMISTS, 8th ed., 1955.

OSER, B. L.: Gauging the Toxicity of Chemicals in Food, Chem. and Eng. News, *29*, 28, 2808–2812, 1951.

PATTERSON, W. I., and LEHMAN, A. J.: Pesticides: Some Chemical Considerations and Toxicological Interpretations, XVIII, *1*, 3–12, 1953

PETTET, A. E. J., and LANE, F. G.: A Study of the Chemical Composition of Wood Smoke, J. Soc. Chem. Ind., *59*, 114–119, 1940

PROOM, H.: Anti-sera for Horse Meat Detection, Jour. Pathology and Bacteriology, *5*, No. 1, 1943

PUBLIC HEALTH SERVICE: An Industrial Waste Guide to the Meat Industry, Public Health Service Publication No 386, U. S. Govt. Printing Office, Washington, D. C., 1954.

RADIATION STERILIZATION OF FOODS: Hearings before the Subcommittee on Research and Development of the Joint Committee on Atomic Energy, Congress of the U. S. 84 Cong., 1st. Sess., May 9, 1955

RADIATION STERILIZATION: Nucleonics, October 1953 through 1955 (Report)

REDIT, H. W.: Mechanical Refrigeration in the Transportation of Perishable Foods, Food Technology 6, 3, 86–90, 1952.
REIMANN, HANS: On the Toxicity of Hydroxylamine, Acta Pharmacol., 6, 285–292, 1950.
REPORT OF THE NEW YORK STATE TRICHINOSIS COMMISSION: "Meat for Millions," Legislative Document No. 52, Albany, New York, 1911.
REPORT OF THE NEW YORK STATE TRICHINOSIS COMMISSION: "The Meat You Eat," Legislative Document No. 35, Albany, New York, 1912.
RUSSELL, W. O., WYNNE, E. S., and LOQUVAM, G. S.: Studies of Bovine Ocular Squamous Carcinoma ("Cancer Eye"), Cancer, 9, No. 1, 1–52, 1956.
SCHWARTZ, B.: Parasites of Domestic Animals Transmissible to Man, The Southern Veterinarian, VII, No. 1, 1954.
SHENK, J. H., HALL, J. L., and KING, H. H.: *Spectrophotometric Characteristics of* Hemoglobins, J. Biol. Chem., *105*, 741–752, 1934.
SINCLAIR, U.: The Jungle, New York, Doubleday, Page and Company, 1906.
STANDARD METHODS FOR THE EXAMINATION OF WATER AND SEWAGE, 8th ed., New York, N. Y., American Public Health Association, 1936.
STARR, M. P., and REYNOLDS, D. M.; Streptomycin Resistance of *Coliform Bacteria* from Turkeys Fed Streptomycin, Am. Jr. Pub. Health, *41.11*, 1375, 1951.
STEINKE, P. K. W., and FOSTER, E. M.: Botulinum Toxin Formation in Liver Sausage, *Food Research*, *16*, 6, 477–484, 1951.
STEPHENSON, M.: Bacterial Metabolism, 3rd, ed., London, Longmans, Green and Co., 1949.
SUTHEIM, G. M.: Introduction to Emulsions, Brooklyn, New York, Chemical Publishing Co., Inc., 1946.
SWEIGERT, B. S.: *Chemistry of Meat Pigments, Proceedings of the Eighth Research* Conference, The Council of Research of the American Meat Institute, University of Chicago, March, 1956.
SYMPOSIUM ON RADIATION STERILIZATION OF FOODS: Nat. Academy of Sciences—National Research Council, Cambridge, Mass., June 26, 1953.
SZENT-GYORGYI, ALBERT: *The Structure and Chemistry of Muscle, Proceedings of the* Fourth Research Conference, The Council on Research of the American Meat Institute, March, 1952.
TARR, H. L. A.: Bacteriostatic Action of Nitrates, Nature, *147*, 417–418, 1941.
TARR, H. L. A., BOYD, J. W., and BISSETT, H. M.: Antibiotics in Food Processing, Agric., and Food Chemistry, *2*, 7, 372–375, 1954.
THE BIOLOGICAL EFFECTS OF ATOMIC RADIATION: National Academy of Sciences—National Research Council, Washington, D. C.
THE JOUR. AMER. MED. ASSN: Pharmacologic and Toxicologic Aspects of DDT, 728, March 10, 1951.
THE USE OF CHEMICAL ADDITIVES IN FOODS: National Academy of Sciences—National Research Council, Pub. No. 398.
THEORELL, HUGO: *Heme-Linked Groups and Mode of Action of Some Hemo Proteins*, Advances in Enzymology, *7*, 265, 1947.
THOMPSON, J. B., and KOCHER, R. B.: Trace Metals in Food Packaging, Modern Packaging *23(9)*+, 119–122, 1950.
THORNTON, HORACE: Textbook of Meat Inspection, 3rd ed., Bailliere, Tindall and Cox, London, 1957.
TRESSLER, D. K., and EVERS, C. E.: The Freezing Preservation of Foods, New York, The Avi Publishing Co., Inc., 1947.
TURK, A., MESSER, P. J., and BLASKIEWICZ, A.: Atmospheric Odors—Their Effect on Flavors of Stored Foods, Agri. and Food Chem., *1*, No. 1, 79–82, 1953.
URBAIN, W. M. *et al.*: The Heme Pigments of Cured Meats, Food Research, *5*, 593–635, 1940.
VAN ROEKEL, H., GRAY, J. E., SHIPKOWITZ, N. L., CLARK, M. K., and LUCHINI, R. M.: Chronic Respiratory Disease Complex in Chickens, University of Massachusetts Experiment Station, Bul. No. 486, March, 1957.
VARTIOVAARA, U.: The Biology of Microbial Associations, Luonnon Tutkija, *53*, 2. 33–36, 1949.
WANG, H., AUERBACH, E., BATES, VIRGINIA, DOTY, D. M., and KRAYBILL, H. R.: A Histological and Histochemical Study of Beef Dehydration IV, Characteristics of Muscle Tissue Dehydrated by Freeze-Drying Techniques, Food Research, *19*, No. 5, 543–556, 1954.
WATSON, R. H.: Some Observations on the Estimation of Muscle Haemoglobin, Biochem. J., *29*, 2114–2121, 1935.
WATTS, BETTY M., ERDMANN, ANNA MARIE, WENTWORTH, JANE: Relation *to Free* Sulphydryl Group to Cured Meat Color, Agri. and Food Chem., *3*, No. 2, 147–151, 1955.

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